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PALEONTOLOGY.—Setigerites *nom. nov. a subgenus of* Productus.[1] GEORGE H. GIRTY, U. S. Geological Survey.

By a regrettable oversight, the writer, in the October number of this Journal, published the name *Setigerella* as a subgenus of *Productus*, overlooking the fact, which has been recently called to his attention, that *Setigerella* had been used by Ehrenberg as long ago as 1872. *Setigerella* Girty is herewith replaced by *Setigerites* Girty, with the same connotation.

BOTANY.—*A New palm from Costa Rica*, Astrocaryum alatum.[2] H. F. LOOMIS, U. S. Plant Introduction Garden, Coconut Grove, Florida. (Communicated by S. F. BLAKE.)

Botanists or others interested in the individual elements of the tropical forests through which passes the railroad leading from Puerto Limon to San Jose, Costa Rica, must have observed at frequent intervals in traversing the lowlands of the Province of Limon, a rather large palm with many graceful pinnate leaves, dark green above but pearl grayish-green on the underside. The trunk itself of the palm may be hidden completely by a varied growth of vines, aroids, ferns, and other small plants which find foothold in the accumulations of humus in the axils of the spiny leaf-bases which remain attached to the trunk long after the leaves have fallen. From the crown of leaves several densely packed clusters of large, spiny fruits droop on viciously spiny stems. Closer inspection reveals other details which show that the palm belongs to the genus *Astrocaryum*, represented in South America by many species but with only two species thus far recognized in Central America, *A. standleyanum* Bailey in Panama and *A. confertum* Wendl. in Costa Rica. Another species, found in Honduras, British Honduras, Guatemala and southern Mexico and long known as *A. mexicanum* Liebm., recently has been removed from *Astrocaryum* and made the type of the genus *Hexopetion*, and may be excluded from consideration here.

[1] Received January 3, 1939.
[2] Received January 6, 1939.

Attempts to identify the Limon Province palm with any of the recognized species of *Astrocaryum* have failed, and the conclusion is forced that, in spite of its abundance and long accessability to collectors, it has remained undescribed. Hence, a technical account of the characters is presented and the specific name *alatum* is proposed in reference to the peculiar winged spines on the under side of the rachis of the leaves. *A. alatum* differs further from both *A. standleyanum* and *confertum* in having female flowers and fruits borne directly on the central spadix instead of on its lateral branches, these having the male flowers continuous from the base to or almost to the apex. The large, spiny, laterally compressed fruits also are distinctive.

In the neighborhood of Cairo, a few miles west of Siquirres, this palm is known only by the Spanish name "Coquito," this name being credited in Dahlgren's *Index of American Palms*, Field Mus. Nat. Hist., Bot. ser., 14, 1936, to the American oil palm, *Corozo oleifera*, in Costa Rica. The names "Zurubre," "Coyolillo," and "Coyolito," listed in the *Index* as applied to *Astrocaryum confertum*, were not recognized by the natives at Cairo as connected with any palm, hence it may be inferred that the range of *confertum* does not approach very close to Cairo.

Astrocaryum alatum Loomis, sp. nov.

Caudex solitarius 3–6 m altus 12–15 cm crassus non spinosus, basibus foliorum spinosis persistentibus; folia usque ad 6 dm longa, segmentis irregulariter contiguis, petiolo subtus spinoso spinis baseos applanatis usque ad 16 cm longis, rachi subtus spinosa spinis brevioribus lateraliter alatis; rami spadicis plusquam 40 omnino staminei; flores femineae in rachi spadicis inter ramos; fructus magnus spinosus apice subrostratus et inermis, in racemo compresso; semen obovatum apice rotundatum basi acutum extus fibrosum fibris complanatis ad foramina vergentibus.

Trunk solitary, 12 to 18 feet high and 5 to 6 inches in diameter, lacking spines but with spiny leaf-bases of the old leaves persistent to the ground; leaves numerous, 30 or more on mature palms, moderately arching, 18 to 20 feet long, the petiole accounting for half to a third of this length; pinnae seldom solitary, commonly in clusters of 2 to 15 segments completely joined, infrequently separated for a short distance above the base, the clusters of pinnae closely placed on the rachis, usually not over 2 inches apart; terminal 6 to 15 pinnae joined into a quadrangular group: one leaf-blade 11.5 feet long has 96 pinnae on the right side grouped in clusters as follows beginning at the base: 6–5–5–7–2–2–6–2–10–7–1–4–4–5–6–2–6–3–13; the 92 pinnae on the left side: 9–10–3–3–4–2–4–4–4–1–7–6–5–4–2–10–1–13; on this leaf the left basal pinna is 30 inches long, a pinna at middle of blade is 37.7 inches long, and the left terminal pinna is 8.2 inches long; individual pinnae, whether solitary or joined in groups, not over 1.2 inches wide; tips of pinnae obliquely erose-truncate; free lateral margins of pinnae with a few tiny brown terete spines; dorsal surface of pinnae dark green, glabrous,

Fig. 1.—*Astrocaryum alatum*, n. sp. *A*, forest palm in fruit, the leaf-bases persistent to the ground. *B*, section of inflorescence of type specimen, natural size. *C*, type inflorescence, less than a third natural size. (*A* by H. F. Loomis, *B* and *C* by O. F. Cook & C. B. Doyle.)

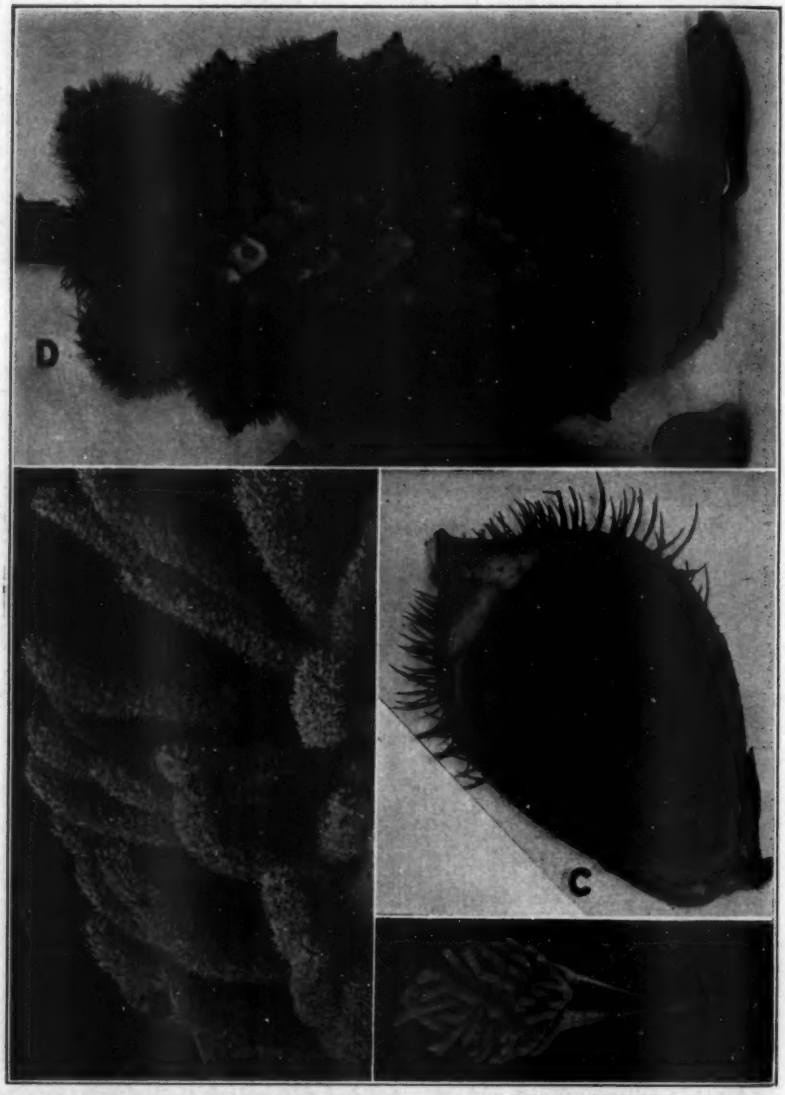

Fig. 2.—*Astrocaryum alatum*, n. sp. *A*, flowering inflorescence in spathe on a section of leaf, greatly reduced. *B*, close view of part of same inflorescence, less than half natural size. *C*, fruit cut to show seed, natural size. *D*, fruit cluster with some fruit removed to show arrangement and form of fruit, basal cups and spadix, less than half natural size. (*A* and *B* by H. Pittier, *C* by O. F. Cook & C. B. Doyle, *D* by H. F. Loomis.)

ventral surface silvery gray-green, densely scurfy and with minute erect spinules or glandular hairs scarcely visible without magnification but apparent to the touch; on young unexpanded leaves the tips of the pinnae on each side of the blade are joined or protected by a continuous strap-like element which separates from the tips when the leaf unfolds and hangs from the apex of the basal pinna, one such unbroken appendage which was collected is 8 feet 5 inches long and about a quarter of an inch wide, the outer end suddenly somewhat thickened and ending in a sheath-like hook with the surface and the outer margin of the strap below it beset with short, brown, ciliaceous spinules; leaf petioles from 6 to 10 feet long, smooth above and concave nearly to the blade, moderately spiny below at base which remains attached to the trunk long after the remainder of the leaf falls, the spines decreasing in number and size above, the basal ones black, simple, attaining 6.5 inches in length and a quarter of an inch across, in cross section lenticular, semi-circular or triangular; further out on the petiole, and especially on the rachis, the spines are flatter and develop a thin supplementary wing-like expansion on the basal half each side, its apical portion often acute and free from the spine, the outer margin sometimes slightly laciniate; spines deep brown, the lateral wings lighter, most spines somewhat reflexed, rising from the proximal side of a pulvinate swelling; rachis with a strong median rib above, ventral basal spines 1 to 1.5 inches long, outwardly decreasing in size and number and not present on the last foot or two of the rachis; spathe densely beset with suberect spines up to an inch long, the spathe splitting along the outer or lower side at flowering and afterward persisting and usually partly covering the fruit cluster; peduncle of inflorescence oval in cross section, less than 2 feet long and up to an inch broad, more densely spiny than any other part of the palm, the spines directed toward the inflorescence, less than half an inch long, flattened, the apical half often bent or even slightly undulate, the basal half densely woolly with lateral margins occasionally moderately winged, surface of peduncle between the spines also densely woolly; inflorescence short and thick, with over 40 simple branches attaining 7 inches in length and borne on a spadix 8 inches or more long; spadix and branches densely woolly between the flowers; branches completely occupied, except occasionally for a half inch at apex, by the male flowers which are closely crowded and in no consistent arrangement, basal or outer envelope of flowers small, chartaceous, with broadly triangular lobes reaching less than half way to the apex of the bud, open flowers not seen but in a detailed photograph taken many years ago the lobes of the inner envelope are not curved outward in the slightest, the elongate anthers borne on filaments twice as long; female flowers sessile, borne directly on the spadix among the simple branches but appearing to have no fixed relation to them, calyx and corolla distally provided with closely applied, ascending spinules, those on the calyx usually more strongly developed; on mature fruits the two basal envelopes are irregular produced at apex but are smaller and lacking the distinctly angular lobes of *A. standelyanum;* fruit clusters several to 8 or 9, infrequently suberect but usually drooping, composed of 25 to 50 large fruits attaining 3 inches in length and so tightly packed that their shape, and that of the enclosed seeds, is affected by mutual compression during growth and several flattened faces are produced on the basal portion of each fruit, distally the fruits are rounded, the surface rusty brownish-green with many erect, curved or straight spines not extending onto the produced, broadly conic tip; flesh of fruit white, firm, an eighth of an inch thick; seeds sometimes exceeding 2

inches in length, strongly oboval, sharply pointed at base, covered with coarse, very closely applied, irregularly ascending, branching fibers converging radially at the three pores; shell an eighth to a quarter of an inch thick, very hard; albumen white, hollow at center.

The foregoing description is based on material gathered in the forest and on palms examined there. In clearings where this palm has been allowed to remain, its aspect is quite different from that of the shade form, as it appears much more compact because the petioles and blades of the leaves are shorter, the latter with the groups of pinnae more closely placed on the rachis. Young palms of this species show a characteristic development of the leaves in that the pinnae almost never are separated; leaf-blades as much as four or five feet long remaining entire or at most with but one or two divisions on each side.

The type specimens deposited in the U. S. National Herbarium under numbers 474451–474457, were collected in the forest at Rio Hondo, Plains of Santa Clara, Costa Rica, altitude 100 meters, May 7, 1903, by O. F. Cook and C. B. Doyle under their number 584. Specimen 474452 is an inflorescence with flowers not quite old enough to open, the other specimens apparently are portions of a single leaf. Photographs of this species, made by O. F. Cook and C. B. Doyle in 1903 and H. Pittier in 1906, have been studied, parts of several of these being herein reproduced, and in addition the writer collected fruiting and leaf material at Cairo, Costa Rica, in 1937 and 1938 and sent it and seed to the Division of Plant Exploration and Introduction, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. Plants from these seeds were distributed to plant experimenters in Florida in 1938 under P. I. number 123380 with the tentative name *Astrocaryum polystachyum*, a name which appeared in the Biologia Centrali-Americana in 1885 without description and which has not yet been thus supported.

Although it is too soon to be certain that this handsome tropical woodland palm will survive and become a part of Florida's subtropical horticulture the growth of these seedlings has been more rapid than with other species of the genus tested at the U. S. Plant Introduction Garden, near Miami, and promises well for the future.

PLANT PHYSIOLOGY.—*Hydrocyanic acid content of sorghum varieties.*[1] JAMES F. COUCH, REINHOLD R. BRIESE, and J. H. MARTIN, Bureaus of Animal and Plant Industry, Washington, D. C.

Sorghum[2] has long been known to be poisonous to animals under certain conditions. The quantity of cyanogenetic glucoside in this plant is one of the factors that determine its toxicity. A large number of sorghum varieties are grown in the United States for feeding to livestock, any one of which may be eaten by animals while in a con-

[1] Cooperative investigation between the Pathological Division, Bureau of Animal Industry, and the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture. Received November 18, 1938.

[2] (Sorghum vulgare, Pers.)

dition to produce poisoning. It is of interest to know to what extent the content of glucoside and, consequently the quantity of hydrocyanic acid, that may be liberated under appropriate conditions, is determined by the variety grown, and whether the differences observed are inherent in the variety or are due to responses to fluctuating environment.

Previous studies (8) have shown that the HCN content of a sorghum variety depends upon the part of the plant analyzed, the age of the tissues, and the growing conditions. Consequently, the relative HCN content of different varieties cannot be determined accurately with only a few samples grown at one point.

It seemed desirable to analyze sufficient samples of a considerable number of varieties grown at several places in the United States to overcome, insofar as possible, some of the discrepancies due to accidental or environmental factors that might affect determinations made from single collections and to determine the effect of certain environmental factors on the relative HCN content of the varieties. Samples were collected in two years, 1936 and 1937, and the analyses are summarized in this paper.

REVIEW OF LITERATURE

Other workers have reported data concerning the relative hydrocyanic acid content of different varieties of sorghum. Brünnich (2) reported 2 to 2.5 times as much HCN in "Imphee" as in Early Amber sorgo. Schröder and Damman (10), in the Argentine, found sorgo slightly higher in HCN than Johnson grass and nearly twice as high as in broomcorn (varieties not stated). Furlong (6) determined the HCN content of sorghum (Guinea corn) and millet at various stages of growth and found the former higher than the latter in ratios varying between 1.5 to 1 and 2.44 to 1. Francis (5) found less HCN in normal mature kafir leaves than in second-growth Sudan grass or in Sudan grass that was 10 inches high. The plants were, however, not of the same age or height and therefore not comparable. Willaman and West (12) published figures indicating that feterita produced considerably more HCN than Orange sorgo. Later (13) they reported figures showing that, except for plants 33 days old, Early Amber sorgo yielded slightly less HCN than "Southern Cane" under Minnesota conditions. Swanson (11) found the following quantities of HCN in the varieties stated: Kafir 36, sorgo 21, and Sudan grass 16 mg per 100 g of green tissue. With special treatment Red Amber

yielded 59.5 and sorgo 48 mg of HCN. Collison (3) published an extensive comparison of the HCN content of different varieties. He analyzed plants 12 to 24 inches high of 17 varieties and two samples of mature hegari and feterita, all grown in Florida. The highest HCN content found was 3.8 mg per 100 g in mature hegari, which is extremely low. Mature feterita gave 3.6 mg. Of the 12 to 24-inch samples, hegari yielded the highest, 3.7 mg, Blackhull kafir was second with 3.3, feterita third with 3.2, and Brown kaoliang fourth with 3.1. Amber sorgo, Japanese Cane, and Napier grass yielded no HCN. Orange sorghum and a milo hybrid were low with 0.75 and 0.2 mg. respectively. Other varieties ranged from 1.6 to 2.6 mg. Piedallu (9) found Early Minnesota Amber sorgo and broomcorn richer in HCN than "S. douro" and Johnson grass. Finnemore and Cox (4), working in Australia, made a number of analyses of sorghum varieties, Sudan grass, and sorghum-Sudan grass hybrids, taking specimens of each at intervals during the growing period. Comparison of the figures for the green plants 64 days old shows the following order of HCN content: Feterita 75, Gooseneck sorgo 69, White African sorgo 45, Sumac sorgo 35, milo 33, Cowper sorgo 25, Collier sorgo 19, Saccaline sorgo 11, and Sudan grass 12 mg per 100 g green weight. The sorghum-Sudan hybrids gave 7 to 27 mg of HCN.

PRESENT INVESTIGATIONS

Environmental Conditions.—Sorghum samples were collected from six stations in the southern Great Plains in 1936 and 1937. The following representatives of the Bureau of Plant Industry grew the sorghums and collected the samples for analysis: for the Division of Cereal Crops and Diseases: J. J. Curtis at Akron, Colo., A. F. Swanson at Hays, Kans.; J. B. Sieglinger at Woodward, Okla.; J. C. Stephens at Chillicothe, Tex.; for the Division of Dry Land Agriculture: B. F. Barnes at Dalhart, Tex.; D. R. Burnham at Tucumcari, N. Mex. The sorghums were grown by the Division of Cereal Crops and Diseases in cooperation with the Colorado, Kansas, New Mexico, and Texas agricultural experiment stations and with the Division of Dry Land Agriculture, Bureau of Plant Industry. The seed used was from previous crops at the station, nearly all from self-pollinated (bagged) heads. Named varieties grown at different stations apparently were identical in type and origin, except for three varieties noted below, although some unconscious selection may have occurred in obtaining seed heads. The feterita samples were of the common

type (C. I.[3] 182) at Hays, Woodward, and Tucumcari, and of the Spur variety at Chillicothe. The Spur variety is later and more leafy than common feterita. All of the hegari were identical in appearance, but the lot grown at Woodward (C. I. 750) was from a later introduction from the Anglo-Egyptian Sudan than the lot (C. I. 620) grown at the other stations. The Dwarf Yellow milo grown at Chillicothe (F. P. I.[4] 18684) appears to be identical with that grown at the other stations (C. I. 332) but the origin may be different. Three kafirs, Western Blackhull, Texas Blackhull, and Sharon are indistinguishable in growth habit or appearance but they were selected from farmers' fields of rather impure kafir in three different States. The wide differences in the rank for HCN content shown later for these three otherwise similar strains may indicate some inherent differences. However, they were not sampled under comparable conditions.

Altitudes.—The altitude in feet at the stations is as follows: Akron, Colo., 4,560; Hays, Kans., 2,000; Woodward, Okla., 2,002; Dalhart, Tex., 3,978; Chillicothe, Tex., 1,406; and Tucumcari, N. Mex., 4,158.

Soils.—The soil at Akron, Colo., is a dark-brown sandy loam underlain with clay at depths of 2 feet or more in most places. At Hays, Kans., the soil is a dark-gray to black loam of the Hays series underlain with a slightly lighter-colored clay loam and clay and is a typical chernozem soil. The soil at Woodward, Okla., is a sandy loam varying in thickness from 1 to 4 feet overlying a reddish clay subsoil and is classed as Amarillo sand. At Dalhart, Tex., the soil is a grayish sandy loam overlying a dark reddish-brown loam or clay loam of the Springer series and has been subjected to considerable dust blowing. The soil at Tucumcari, N. Mex., is a loose reddish-brown sandy loam of the Otero series that blows readily when unprotected by vegetation. The soil on Texas Substation No. 12, Chillicothe, Tex., is mostly a dark reddish-brown clay loam of the Vernon series.

Weather.—The mean monthly temperatures at the six stations for 1936 and 1937, compared with long-time averages for the five months, May to September, inclusive, are shown in Table 1. The precipitation for the same months is presented in Table 2. Temperatures were above average in 1936 and 1937 at all six stations, July and August being especially hot during the growing season. Precipitation for the five months was materially below average in both years at Hays, Kans., Dalhart, Tex., and Woodward, Okla., and in 1937 at Akron, Colo.,

[3] C. I. refers to accession number of the Division of Cereal Crops and Diseases, formerly Office of Cereal Investigations.

[4] F. P. I. refers to accession number of the Division of Plant Exploration and Introduction, formerly Office of Foreign Plant Introduction.

TABLE 1.—MEAN MONTHLY TEMPERATURE IN °F, DURING THE GROWING SEASON IN 1936 AND 1937, AND THE AVERAGE MONTHLY TEMPERATURE AT SIX STATIONS

	May	June	July	August	September	Average
1936						
Akron, Colo.	60	70	79	74	63	69
Hays, Kans.	66	76	85	84	71	76
Dalhart, Tex.	65	75	79	79	67	73
Tucumari, N. Mex.	68	77	79	80	68	74
Woodward, Okla.	69	80	87	88	72	79
Chillicothe, Tex.	74	84	86	88	76	82
1937						
Akron, Colo.	59	66	75	77	65	68
Hays, Kans.	67	75	82	84	70	76
Dalhart, Tex.	66	73	79	80	70	74
Tucumcari, N. Mex.	68	74	80	82	72	75
Woodward, Okla.	71	77	86	86	73	79
Chillicothe, Tex.	75	80	86	86	77	81
Average						
Akron, Colo. (1912–1937)	56	67	74	71	62	66
Hays, Kans. (1893–1937)	62	72	79	78	69	72
Dalhart, Tex. (1906–1937)	62	72	78	76	68	71
Tucumcari, N. Mex. (1915–1937)	65	75	79	77	70	73
Woodward, Okla. (1914–1937)	67	77	82	81	73	76
Chillicothe, Tex.	71	80	84	83	75	79

and Chillicothe, Tex. The months of June, July, and August were very dry at Chillicothe in 1936. The precipitation at Tucumcari, N. Mex., was slightly above average both years.

The season of 1936 in the Great Plains was characterized by ex-

TABLE 2.—MONTHLY AND SEASONAL PRECIPITATION DURING THE GROWING SEASON IN 1936 AND 1937 AND AVERAGE MONTHLY PRECIPITATION

	May	June	July	August	September	Total
1936						
Akron, Colo.	3.51	3.04	1.85	2.17	3.03	13.60
Hays, Kans.	5.40	.60	.60	1.89	1.87	10.36
Dalhart, Tex.	3.67	2.44	1.49	.25	1.19	9.04
Tucumcari, N. Mex.	1.74	2.01	4.40	2.02	1.42	11.59
Woodward, Okla.	5.21	2.37	.23	.54	3.53	11.88
Chillicothe, Tex.	2.59	1.22	.46	0	13.67	17.94
1937						
Akron, Colo.	1.26	2.40	2.38	1.13	1.65	8.82
Hays, Kans.	1.73	1.98	4.28	2.58	1.71	12.28
Dalhart, Tex.	5.86	1.23	1.68	1.27	1.27	11.31
Tucumcari, N. Mex.	5.72	2.42	.87	.86	2.09	11.96
Woodward, Okla.	2.37	1.68	.51	2.28	3.91	10.75
Chillicothe, Tex.	1.50	2.63	1.81	2.91	.99	9.84
Average (24 or more years)						
Akron, Colo. (1908–1937)	2.85	2.40	2.57	2.19	1.46	11.47
Hays, Kans. (1906–1937)	3.07	3.77	2.71	2.95	2.02	14.52
Dalhart, Tex. (1908–1937)	2.82	3.08	2.30	2.58	1.43	12.21
Tucumcari, N. Mex. (1905–1937)	2.21	2.02	2.40	2.91	1.38	10.92
Woodward, Okla. (1914–1937)	3.47	2.96	1.84	2.44	2.75	13.46
Chillicothe, Tex. (1906–1937)	3.20	3.16	2.30	2.37	2.97	14.00

treme drought and high temperatures. Rains during May were ample for securing stands and maintaining early growth of sorghums. In general, the rains ceased about the first of June and sorghums having exhausted the available soil moisture, began showing the effect early in July at several stations. Showers at Akron, Colo., about July 11 and also prior to August 8 at Hays, Kans., prior to August 3 at Dalhart, Tex., and at Tucumcari, N. Mex., between August 25 and September 1, maintained or revived the plants somewhat. Plants were suffering from a shortage of moisture at Akron, Colo., on July 25; at Chillicothe, Tex., on July 14; at Tucumcari, N. Mex., on August 5; at Dalhart, Tex., after August 12; at Hays, Kans., on August 20; and at Woodward, Okla., on August 5. Later in the season, in September, ample rains fell at Chillicothe, Woodward, and Akron, but this moisture came too late to produce normal crop development, particularly in view of the early frosts. The crop at all stations thus suffered severely from drought.

In 1937, heavy rains occurred during the latter part of May at Dalhart and Tucumcari, but May rainfall was below average at the other four stations. Sufficient moisture was available for germination and fair early growth of the sorghums at all stations, but drought beginning after the middle of June at most of the stations affected the growth and development of the plants. Rainfall in July was below average at all stations except Hays and in August at all stations except Chillicothe. The crop was greatly retarded and stunted by drought at Dalhart, Tucumcari, and Hays, and growth was delayed at Woodward until rains came in September.

EXPERIMENTAL METHODS

Samples were collected at intervals during the growing season from most of the varieties studied. In some cases the number of collections was limited by a scarcity of material or by the condition of the crop but, wherever possible, samples were taken at intervals from the time the plants were 6 to 10 inches high until growth was stopped by frost.

During 1936 whole plants were sliced into small sections, the material intimately mixed, and duplicate 100 g samples weighed into pint preserving jars, covered with preservative, and shipped to the laboratory at Washington, D. C., where they were analyzed as soon as possible, 0 to 12 days, after arrival. After some experimenting with preservatives, 15 percent alcohol was used, and all figures obtained by the use of other preservatives in 1936 were discarded as

inaccurate. It is now known that 15 percent alcohol is not an ideal preservative and that data obtained from samples preserved in it for longer than 7 to 10 days may be quite inaccurate. However, the data have a certain value for comparative purposes and indicate the relative proportions of HCN yielded by the different varieties.

In 1937, some important changes in collection and preservation were made with the result that the figures obtained from these collections are regarded as much more accurate than those for 1936. The plants were minced through a food chopper, mixed thoroughly, and the weighed samples preserved in mercuric chloride solution (1) in the proportion of 1 g of mercuric chloride to 100 g of fresh plant material. Experience with this preservative indicates that, in this strength, excellent preservation may be obtained for as long as six months. The samples were shipped to the laboratory and were analyzed four to six weeks after collection. The technique of analysis is described elsewhere (1).

In 1936 no moisture determinations were made on the collected samples and the figures obtained refer to the HCN content of green plant only. In 1937 moisture determinations were made on all samples except at Akron where the samples were only air-dried. For that year figures are available for the HCN content of fresh tissue and calculations are recorded on a moisture-free basis at all stations except Akron, where the air-dry basis was used.

VARIETAL DIFFERENCES

The average HCN content of all samples of the varieties collected in 1936 at each of the six stations is shown in Table 3. The figures are averages of eight collections made at Chillicothe, Tex., eight at Hays, Kans., four at Tucumcari, N. Mex., two each at Woodward, Okla., and Akron, Colo., and in part at Dalhart, Tex. Data from Akron are shown for two separate plantings, one on fallow land and the other on land in which moisture was very deficient, because Sudan grass had been grown the previous year. At Dalhart, samples were taken from two plantings made on June 4 and June 15. Five collections were made from the former and two from the latter planting.

The weighted average for each variety was calculated from the samples taken at the same time as were samples of Sumac sorgo. Since some samples were lost by breakage during transit and a few were discarded for insufficient preservation the figures for the corresponding Sumac sorgo samples were excluded from the averages. The varieties are listed in the order of comparative percentages. The

TABLE 3.—AVERAGE HYDROCYANIC ACID CONTENT OF 31 SORGHUM VARIETIES GROWN AT SIX STATIONS IN 1936

Variety	Samples	Hydrocyanic acid in 100 grams of fresh tissue								Weighted average of comparable samples		
		Akron, Colo.		Chillicothe, Tex.	Dalhart, Tex.		Hays, Kans.	Tucumcari, N. Mex.	Woodward, Okla.			
		On fallow	After Sudan grass		June 4	June 15				Variety named	Sumac in same tests[1]	Percentage of Sumac
	Number	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg
Feterita	41			49.7			42.3	16.9	81.0	44.5	33.5	132.8
Dawn kafir selection	13						31.9			31.8	27.7	114.8
Scarborough broomcorn	4								71.3	71.3	62.1	114.8
Wheatland	4	15.4	21.0							18.2	16.1	113.0
Chiltex	14			44.5						44.5	39.6	112.4
Western Blackhull kafir	16						33.8			33.8	30.3	111.6
Red Amber sorgo	14			39.8						39.8	37.8	105.3
Standard Blackhull kafir	4								66.4	66.4	63.1	105.2
White darso	4								66.1	66.1	63.1	104.8
Hegari	38			33.9	30.5	40.9			70.2	33.9	32.8	103.4
Sumac sorgo[1]	58	13.2	18.9	35.1	27.5	36.9	26.5	17.1	63.1	29.9	29.9	100.0
Sharon kafir	4								57.1	57.1	63.1	90.5
Finney milo	12							11.0	65.6	29.2	32.4	90.1
Honey sorgo	32			38.8	18.6	23.2		12.9		26.3	30.0	87.7
Atlas sorgo	37	9.2	12.0		21.2	27.5	30.0	11.0	49.7	26.8	31.3	85.6
Early Kalo	4	9.5	16.4							12.9	16.1	80.1
Evergreen dwarf broomcorn	4	7.9	17.7							12.8	16.1	79.5
Texas Blackhull kafir	24			29.1				9.0		22.5	28.7	78.4
Dawn kafir	12	8.1	15.9					13.6		13.1	16.8	78.0
Darso	27			28.9	14.9	26.8		17.8	65.9	30.1	38.9	77.4
Dwarf Yellow milo	44	13.5	14.9	30.2	16.3	18.5	25.6		55.8	27.2	36.3	74.9
Pink kafir	4	10.5	24.6							12.0	16.1	74.5
Kansas Orange sorgo	52	7.1	18.4	26.9	19.9	24.0	24.0	12.7		21.4	31.1	68.8
Acme broomcorn	11				17.5			14.4		15.2	22.6	67.3
Leoti sorgo	30	7.6	10.5		12.1	11.6	20.4			16.4	26.1	62.8
Freed	4	7.1	12.2							9.6	16.1	59.6
African Millet sorgo	25			24.9	14.2	19.2				21.4	36.3	59.0
Quadroon	12			22.1						21.4	36.9	58.0
Black Amber sorgo	4	9.0	8.1							8.5	16.1	52.8
Sunrise kafir	14				13.9	15.8			30.5	18.6	39.0	47.7
Early Red kafir	14				11.7	10.0				11.4	29.6	38.5

[1] Early Sumac sorgo at Akron, Dalhart, and Hays.

number of samples of some varieties was limited and the reliability of the average HCN contents shown for these varieties is questionable. Comparable averages based upon 10 to 16 or more samples, however, should indicate the relative HCN content of the varieties with considerable dependability. The data from Woodward, Okla., are based on only two collections made on August 17 and 29 at a time when the HCN content of the plants was at a high seasonal level. At the other stations, with the exception of Akron, the data include those from collections made in September and October when the HCN content normally is low.

A considerable difference in the HCN producing capacity of the varieties is indicated in Table 3. Varieties like feterita, Chiltex, and hegari tended to produce relatively large quantities, and Leoti sorgo, Early Red kafir, Dawn kafir, and Acme broomcorn produced one-quarter to one-third as much. If the lethal level of HCN in fresh sorghum for sheep be assumed as about 20 mg per 100 g, in accordance with the suggestion of Hindmarsh (7), which in the main agrees with some unpublished results of the Bureau of Animal Industry, then the average sample of 20 of the 31 varieties would be likely to produce poisoning if livestock gained access to the growing plants. However, since the figures are averages, and include data from mature plants that normally contain little HCN, it should be emphasized that any and all of the varieties listed may be highly dangerous at certain stages of growth, and none is to be regarded as always nontoxic.

The quantities of HCN in the varieties do not show the same relations when the varieties are grown at different stations. At Chillicothe, Honey sorgo was a tenth higher than Sumac sorgo, a fourth lower at Tucumcari, and a third lower at Dalhart. Feterita was only slightly lower in HCN than Sumac sorgo at Tucumcari but was distinctly higher at Chillicothe, Woodward, and Hays. HCN in Atlas was two-thirds to four-fifths that of Sumac sorgo except at Hays, where it was 13 percent higher. Darso was a little higher than Sumac sorgo at Woodward and Tucumcari but only half as high in the June 4th planting at Dalhart.

The ranking of varieties in order of HCN content in Table 3 is not in general agreement with opinions based upon casual reports of sorghum poisoning on farms. Most cases of sorghum poisoning appear to occur in fields of kafir and sorgo. The Black Amber variety is the leading sorgo in the northern half of the United States, including South Dakota, Nebraska, Colorado, and northern Kansas, sections where poisoning seems to be of frequent occurrence. Analyses of

Black Amber from Akron show it to be relatively low in HCN. This, however, may be a result of a more advanced stage due to the relatively early maturity of the variety. Reports of poisoning in animals from eating hegari are rare but this may be due to the fact that very little hegari is grown north of Oklahoma. Milo and broomcorn usually are headed from standing stalks which are left in the field. The fields of these sorghums often are pastured after harvest, and reports of poisoning on milo and broomcorn are extremely rare, although analyses indicate that both contain toxic quantities of HCN at times. It is probable that sufficient seed and mature leaves and stalks are consumed along with the young second growth leaves so that dangerous quantities of the latter are avoided.

TABLE 4.—HCN CONTENT IN MG PER 100 G OF DRIED LEAVES AND GREEN PLANTS OF SORGHUM VARIETIES COLLECTED AT CHILLICOTHE, TEX., SEPT. 11, 1936

Variety	Moisture content of dried leaves	HCN content		
		Dried leaves	Whole green plant	
			Wet basis	Dry basis[1]
	percen	mg	mg	mg
Sumac sorgo	9.33	91.6	48.1	192.4
Darso	9.39	86.9	29.1	116.4
Spur feterita	8.94	71.1	72.8	291.2
Hegari	9.50	59.1	51.2	204.8
Chiltex	8.55	54.8	59.1	236.4
Texas Blackhull kafir	9.69	52.5	36.2	144.8
Kansas Orange sorgo	10.34	43.2	43.1	172.4
Red Amber sorgo	8.77	40.1	32.7	130.8
Sourless sorgo	8.72	38.5	35.0	140.0
Dwarf Yellow milo (F.P.I. 18684)	6.64	31.2	38.3	153.2
Honey sorgo	6.96	24.9	51.3	205.2
Quadroon	8.32	20.6	30.0	120.0

[1] Calculated on the basis of the assumed approximate average moisture content of 75 percent in the green plants.

Table 4 shows a comparison of the HCN content of fresh green plants and dried leaves of the same varieties collected at Chillicothe, Tex., on September 11, 1936. Samples were taken of whole plants and preserved for analysis and, at the same time, leaves of the same varieties were selected and dried. The varieties are listed in order of the HCN content of the dried leaves. Sumac sorgo was highest in HCN in the dried leaves and fifth in content in the green plants. Spur feterita was highest on the basis of the green whole plants, but was third in HCN content of the dried leaves. Darso, which was lowest in HCN in the green whole plants, was second high on the basis of the dried leaves. While the fresh plants of hegari and Honey sorgo had about the same HCN content, the dried hegari was more than twice

as high as Honey sorgo. Chiltex was second in the green whole plant and fifth with respect to the dried leaves. These data suggest not only that the comparative quantities of HCN differ in the dried leaves as compared with the whole plant but also that varieties may lose HCN at different rates or in varying degrees on drying. Thus, hegari and Chiltex lost a larger percentage than did Sumac sorgo and much less than did Honey sorgo. Darso lost comparatively little, while Quadroon, which was about equal to darso in the green state, lost the greater part of its HCN when dried.

The toxicity of the dried samples is of interest. Several of the varieties were force-fed to sheep. Feterita, hegari, and darso, fed in doses calculated to contain from 1.5 to 2.5 minimal lethal doses of HCN, produced serious symptoms of poisoning from which the animals recovered after treatment. Texas Blackhull kafir produced symptoms of poisoning when fed forcibly in doses of 0.9 to 1.1 m.l.d. from which the sheep recovered without treatment. It appears that dried sorghums containing somewhat less than 52.5 mg of HCN per 100 g are potentially dangerous in hay. Of the varieties listed in Table 4, Dwarf Yellow milo, Honey sorgo, and Quadroon might possibly be considered only slightly dangerous while the other varieties contained sufficient HCN to produce more or less serious symptoms, and several of the varieties were sufficiently high in HCN to cause very serious effects, if not death, if eaten in the quantities usually consumed at a single feeding under the conditions of the above experiment.

During the season of 1937 attention was concentrated on a few varieties. Feterita, Sumac sorgo, hegari, and Dwarf Yellow milo were grown at each station. Texas Blackhull kafir was grown at Chillicothe, Dalhart, and Tucumcari, Western Blackhull kafir was grown at Hays, Sharon kafir at Woodward, and Dawn kafir at Akron. The first three varieties of kafir are indistinguishable morphologically and in time of maturity, although it is possible that they may differ in HCN content. The data in Table 3 suggest that these three kafirs may differ in HCN content. Collections of Sudan grass were made at Akron, Chillicothe, and Woodward. Hegari was sampled as a whole plant. With the other varieties, the whole plant was sampled until the flag leaf appeared. After that only the leaves were sampled, as it had been ascertained that the stalks contain so little HCN that they are not important in animal poisoning. Collections were continued at most of the stations until frost occurred. The data are fairly complete for the different varieties from the seedling to the ripe stages of

growth. Comparable collections of feterita and Sharon kafir were also made from the plots grown by the writers at Arlington Farm, Arlington, Va. Some of these samples were analyzed immediately upon collection, as well as after preservation in mercuric chloride solution. The results presented in Table 5 represent the averages for each variety at each station, with a general average for all of the stations. Dawn kafir, grown only at Akron, is not included in the averages for the kafirs. The data are calculated to mg of HCN per 100 g of dried

TABLE 5.—HCN CONTENT OF SORGHUM VARIETIES AT SIX STATIONS IN 1937

Variety	HCN content of 100 g dry matter							
	Akron	Chillicothe	Dalhart	Hays	Tucumcari	Woodward	Average	Percentage of Sumac
	mg	mg	mg	mg	mg	mg	mg	mg
Young Whole Plants								
Feterita	200.3	156.3	212.9	199.1	176.4	150.9[1]	182.6	95.5[5]
Sumac sorgo	203.2	171.8	239.3	216.6	165.7	138.4[2]	172.5	100.0
Hegari	121.6	107.2	209.6	181.4	183.2	144.2[2]	157.8	84.4
Dwarf Yellow milo	182.2	112.0	168.8	158.9	128.2	107.2[2]	142.8	75.6
Kafir	133.2[1]	114.5	107.6	138.0	114.7	88.4[2]	112.6[4]	61.7[4]
Sudan grass	161.1	121.2	—	—	—	48.2	110.1	58.9
Fully-developed Leaves								
Feterita	197.1	133.4	156.6	217.1	141.5	146.3	165.3	95.2
Sumac	213.1	202.3	152.7	219.8	80.4	—	173.6	100.0
Hegari	193.0	161.6	—	208.1	110.7	—	168.3	96.9
Dwarf Yellow milo	154.9	72.6	79.3	123.1	64.4	—	98.8	56.9
Kafir	166.6[1]	69.7	50.5	136.9	87.3	—	86.1[4]	59.6[4]
Average of all	175.1	138.4	152.8	179.9	125.3	111.0	147.1	—

[1] 3 collections.
[2] 6 collections.
[3] 4 collections.
[4] Dawn kafir, not included in averages.
[5] Adjusted to comparable samples of Sumac sorgo from Woodward.

plant, air-dried in the case of Akron. These figures also were calculated to a common basis, taking Sumac sorgo again as a standard and calculating each station separately.

In general, the results are similar to those obtained in 1936. Feterita hegari, and Sumac sorgo are high in HCN while milo and the kafirs are low. The principal change is the change in position of Sumac sorgo from third place among the varieties grown at more than one station in 1936 to first in 1937 both for young whole plant and for leaves. This relationship was maintained at all of the stations except at Tucumcari, where Sumac was lower than both hegari and feterita

both as young whole plant and as leaves, and at Dalhart where, as leaves, it was below feterita. At all stations milo and the kafirs were relatively low except Dawn kafir, grown only at Akron, Colo., the average for which is not strictly comparable with the averages for other varieties grown at five or six stations.

Selection for low hydrocyanic acid content in Dakota Amber sorgo by C. J. Franzke, of the South Dakota Agricultural Experiment Station, Brookings, S. Dak., has been in progress for some years. Seed of a strain (No. 39-30-S) having a low HCN content was obtained from Mr. Franzke and planted at Dalhart, Tex., in comparison with the unselected Dakota Amber variety. Three collections of the two

TABLE 6.—HYDROCYANIC ACID CONTENT OF A DAKOTA AMBER SORGO SELECTION 39-30-S IN COMPARISON WITH THAT OF UNSELECTED DAKOTA AMBER, FETERITA, AND SUDAN GRASS GROWN AT DALHART, TEX. IN 1937

Variety	HCN content in 100 g of oven-dry tissue		
	Whole Plants		Leaves
	August 6	August 13	September 10
	mg	mg	mg
Dakota Amber sorgo (selection 39-30-S)	161.7	61.7	66.8
Dakota Amber sorgo (unselected)	217.1	204.8	181.3
Feterita	254.3	232.3	200.6
Sudan grass	77.6	67.5	9.3

strains were analyzed and the results are shown in Table 6 in comparison with feterita and Sudan grass collected the same day. The Sudan grass was older than the sorghum varieties and, consequently, not strictly comparable.

The first collection was made on August 6, 1937, when the sorghum plants were about 14 inches and the Sudan grass about 24 inches in height. The data indicate that the selected strain, which also was earlier in maturity, is distinctly lower in HCN than unselected Dakota Amber and, in some cases, may be as low as Sudan grass. Despite this, the HCN content of the August 6 sample of selection No. 39-30-S (31.7 mg on a green basis) was above the supposedly toxic limit of 20 mg.

ENVIRONMENTAL DIFFERENCES

The relative standing of the various stations with reference to the quantities of HCN found in the plants in 1936 was determined by averaging the determinations shown in Table 3 of Sumac (or Early Sumac) and Dwarf Yellow milo (or Finney milo) at each station. The average HCN contents thus determined were as follows: Woodward,

60.0; Chillicothe, 32.7; Akron, 30.2; Hays, 26.1; Dalhart, 24.8; Tucumcari, 14.1. The high values at Woodward are due in part to the limited number of collections made only in August at a stage when the HCN content was high. A direct comparison of differences between

TABLE 7.—HYDROCYANIC ACID CONTENT OF WHOLE PLANTS OF HEGARI GROWN AT DIFFERENT STATIONS IN 1937

Station	Number of samples	Age at first sample	Average HCN content[1]
		Days	mg
Tucumcari, N. Mex.	16	34	188.0
Dalhart, Tex.	14	36	175.1
Chillicothe, Tex.	14	35	140.0
Akron, Colo.	16	37	117.0
Woodward, Okla.	16	38	114.4
Average		36	146.8

[1] Mg per 100 g dry matter.

stations was obtained in 1937 from collections of whole plants of hegari made during an eight-week period between July 20 and September 17. The data are shown in Table 7. On the basis of the average HCN content of hegari at five stations, Tucumcari and Dalhart are highest and Woodward and Akron lowest. The comparative ratings for the stations in 1937 show some striking differences from those for 1936 (Table 8). Tucumcari moved from sixth to first place, Dalhart from fifth to second, Woodward from first to sixth,

TABLE 8.—RELATIVE RANK OF STATIONS FOR HCN COMPARED WITH PRECIPITATION AND TEMPERATURE

Station	Altitude (feet)	Relative rank for HCN content of sorghum		Precipitation (inches)				Mean temperature °F.	
				July and August		June, July and August		July and August	
		1936	1937	1936	1937	1936	1937	1936	1937
Tucumcari, N. Mex.	4,158	6	1	6.42	1.73	8.43	4.15	79.5	81.0
Dalhart, Tex.	3,978	5	2	1.74	2.95	4.81	4.18	79.0	79.5
Chillicothe, Tex.	1,406	2	3	0.46	4.72	1.68	5.58	87.0	86.0
Hays, Kans.	2,000	4	4	2.49	6.86	3.09	3.71	84.5	83.0
Akron, Colo.	4,560	3	5	4.02	3.51	7.06	5.91	76.5	76.0
Woodward, Okla.	2,002	1	6	.77	2.79	3.14	6.40	87.5	86.0

Chillicothe from second to third, and Akron from third to fifth. While comparable figures for whole hegari were not available from Hays in 1937 the general result from all varieties shows that Hays was running slightly above Akron, which would place this station in fourth place, as in 1936.

These changes may be in part correlated with the rainfall for the

months of July and August, the period in which rainfall would be most likely to affect the averages for HCN in the sorghums. In both years the two highest-standing stations were relatively low in rainfall, but otherwise little relationship between rainfall and HCN is evident. It is possible that, above a critical point, available moisture may lead to HCN production by stimulating the growth of new tissue. In plants that have not begun to produce heads, HCN production in excess of utilization may be correlated with rapid growth of new tissues.

In this connection the results obtained with feterita and Sharon kafir grown at Arlington, Va. in 1937 are of interest. The crops were grown on low flat land with a high water table, and the season was unusually wet. At no time was the ground dusty and much of the time the surface was moist to muddy. Under these conditions the average HCN content for young whole feterita plants was 204 mg per 100 g of dry matter as compared with the average of 182.6 for the western stations (Table 5), and for leaves 82.8 mg for Arlington and 165.3 mg for the western stations. The average HCN content of young whole Sharon kafir plants was 128.2 mg as compared with 88.4 mg for whole young plants from Woodward, and 40.1 mg for leaves, against an average of 86.1 mg for kafirs grown at four western stations. Samples of leaves of Sharon kafir were not taken at Woodward.

It thus appears that young plants grown on the Atlantic seaboard under adequate moisture conditions may still produce quantities of HCN comparable with those grown under drought conditions on the Great Plains, but the HCN production appeared to fall off more sharply when the plants began to mature.

No correlation between altitude and HCN content of sorghums grown at a station could be drawn, and the same is true of the mean temperatures for July and August of both years.

SUMMARY

Plant and leaf samples of 33 sorghum varieties grown at one or more of six stations in the Great Plains area in 1936 and 1937 were analyzed for HCN content at various stages of growth. It appears that any variety tested may contain sufficient HCN at times to be toxic to animals. Feterita, hegari, Chiltex, and Sumac sorgo tended to be high in HCN; milo, darso, Atlas sorgo, and Kansas Orange sorgo were intermediate; and Leoti sorgo and "African Millet" sorgo and a selected strain of Dakota Amber sorgo were rather low in HCN. Varieties of kafir showed wide variation, some being high and others low in HCN. The comparative rank among the stations in average

HCN content of the samples was different in the two seasons. The HCN content of the sorghums showed some tendency to be high where summer precipitation was lowest but there was no consistent relation between HCN content of sorghum and differences in temperature. Young feterita plants grown under abundant moisture conditions at Arlington, Va., contained as much HCN as the average for the six Great Plains stations where drought was severe.

The HCN content (calculated on a dry matter basis) of dried leaves of sorghum varieties ranged from about 12 percent to 75 percent of that of the whole green plant.

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ZOOLOGY.—*Predaceous nematodes of the genus* Aphelenchoides *from Hawaii.*[1]

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In a recent publication Linford and Oliveira[2] pointed out that certain species of the nematode genus *Aphelenchoides* Fischer, 1894 are predaceous and number among their prey other nemas including the root-knot nematode, *Heterodera marioni* (Cornu, 1879) Goodey, 1932. These investigators have been able to rear five species of predaceous *Aphelenchoides* on agar cultures where their feeding habits could be studied. A population of some other nematode was first established on these cultures to provide food for the predators. Linford and

[1] Received February 3, 1939.
[2] Science 85: 295–297. 1937.

Oliveira kindly forwarded to the writer cultures of these five *Aphelenchoides* species and the following descriptions and drawings are based on a study of the material thus provided. As the bionomics of these nematodes are being studied by the above mentioned investigators the present paper deals exclusively with taxonomy and morphology.

The species described herein belong to a group for which "long tailed" *Aphelenchoides* is perhaps an appropriate designation. The first of this group to be described was *Aphelenchoides longicaudatus* (Cobb, 1893) Goodey, 1933. This species is poorly characterized and probably unrecognizable but in one particular it seems to differ from all the subsequently described "long tailed" species including those described in the present paper: the length of the tail is at least twice as great as the distance from the vulva to the anus. The other species that have been added to this group are as follows: *A. tenuicaudatus* (de Man, 1895) Goodey, 1933, *A. winchesi* (Goodey, 1927) Filipjev, 1934, *A. demani* (Goodey, 1928) Goodey, 1933, *A. elmiraensis* van der Linde, 1938, and *A. oswegoensis* van der Linde, 1938.

Linford and Oliveira tentatively identified one of their species as *A. tenuicaudatus*. This identification apparently is correct. A second species is described herein as *A. winchesi* var. *filicaudatus*, n. var. The remaining three species are regarded as new and for these the names *A. linfordi*, n. sp., *A. oliveirae*, n. sp. and *A. oahuënsis*, n. sp. are proposed.

There is considerable resemblance between females of some of these predacious *Aphelenchoides* and the female of *Seinura mali* Fuchs, 1931. The similarity of the stylet, the esophageal bulb and the tail is noticeable. Fuchs neither mentions nor figures the esophageal glands. On the other hand the tail of the male of *S. mali* differs conspicuously from that of all the predaceous species of which the male is known. Precisely what characters serve to differentiate the genus *Seinura* from the genus *Aphelenchoides* is not altogether clear to the writer but on the basis of Fuchs' description probably the male tail constitutes the most important differentiating character. If this is true none of the species described in the present paper belong in the genus *Seinura*.

As these five species of predaceous *Aphelenchoides* are quite similar in structure a few comments on their common morphological characteristics seem pertinent. Beginning at or somewhat anterior to the anus the body of the female tapers more or less evenly and ends in a long, pointed, conical tail. The longitudinal, cuticular modifications that define the so-called lateral fields of *A. parietinus* and *A. fragariae* were not observed. If such cuticular modifications occur they are very

indistinct. The head is more or less distinctly set off and is divided into six, slightly elevated, lip-like sectors. These lip-like elevations are slightly more conspicuous on some of the species (i.e. *A. tenuicaudatus*) than on others. The stylet is divided into an anterior, conical part and a posterior, cylindrical part with the anterior opening on the ventral side. At the junction of these two parts the stylet is encircled by a structure somewhat resembling the so-called guiding ring of dorylaims. This structure is most conspicuous in *A. tenuicaudatus* but is present and more or less distinct in all the species. The esophageal gland mass is exceptionally large. It is composed of a large gland, presumably the dorsal, constituting the posterior two-thirds or more of the mass and a pair of smaller glands, presumably the subventrals, constituting a greater part of the anterior third of the mass. The nucleus of the largest gland was seen in all the species but the nuclei of the smaller glands were more difficult to observe in toto preparations. Secretion from the esophageal glands fills a considerable area in the anterior part and a lesser area in the posterior part of the bulb with more or less secretion between these two areas just dorsal to the wall of the central lumen. The bulb is relatively large and somewhat elongated but varies considerably in shape, depending on the amount of secretion contained and the state of muscular contraction. Near the anterior end of the bulb the wall of the esophageal lumen is distinctly interrupted by at least one, or perhaps several, minute openings. Although undoubtedly present, phasmids were not observed, as a special technic necessary to make them visible was not employed.

The outlines of the drawings and all measurements were made on specimens killed in a 5 per cent solution of commercial formalin (about 2 per cent formaldehyde) heated to 70°C. Living specimens were used to determine many of the morphological details.

Aphelenchoides winchesi (Goodey) Filipjev var. **filicaudatus**, n. var.

Synonymy.—*Aphelenchus winchesi* Goodey. Jour. Helminth. 5(4):2–7, figs. 1–5. 1927. *Aphelenchoides winchesi* (Goodey). Filipjev, *Harmful and useful nematodes in rural economy*. Moskva, Leningrad. p. 236, fig. 203, G-H. 1934.

Measurements.— ♀ : Length 800 to 880μ; width 23 to 26μ; length of esophagus, 80 to 86μ; length of tail, 138 to 187μ; a, 31 to 35; β, 9.7 to 10.6; γ, 4.5 to 6; V, 61 to 66%.

Description.—Male unknown. Female (Fig. 1,B) with cuticular striae fine, moderately obscure. Head region relatively short, only faintly set off. Stylet 18 to 19μ, without basal knobs. Excretory pore from opposite middle to opposite posterior margin of esophageal bulb. Tail tapers more or less evenly and ends in a long filiform process. Anus very inconspicuous. Intestinal lumen between vulva and anus often wide and filled with fecal ma-

terial. Vulva relatively inconspicuous; postvulvar uterine sac very short; ovary outstretched, frequently extending nearly to nerve ring. Eggs 59 to 65μ by 19 to 21μ.

Habitat.—Soil.

Locality.—Island of Oahu, Territory of Hawaii, U.S.A.

Comparisons and affinities.—This variety, based on females only, differs from the type species in having (a) a longer tail (120 to 130μ in type, 138 to 187μ in present variety), (b) a shorter stylet (24 to 27μ in type, 18 to 19μ in present variety) and a somewhat more anteriorly situated excretory pore ("a short distance behind level of bulb" in type, from about opposite middle to about opposite posterior margin of bulb in present variety). In addition the vulva seems to be situated somewhat more anteriorly (at 70 to 75% in type, at 61 to 66% in present variety). As Linford and Oliveira had cultures of this variety under observation for a considerable period and neither they nor the present writer observed males, one may conclude that at least males are very rare. This constitutes another difference between the type species and the present variety.

Aphelenchoides tenuicaudatus (de Man) Goodey

Synonymy.—*Aphelenchus tenuicaudatus* de Man. Trans. Liverpool Biol. Soc. 10: 77–81, pl. 3, figs. 1, 1a, 1b, & 1d, pl. 2, fig. 1c. 1895. *Aphelenchoides tenuicaudatus* (de Man). Goodey, *Plant parasitic nematodes and the diseases they cause.* London, p. 250, fig. 111. 1933.

Measurements.—♂: Length, 650 to 720μ; width, 17 to 21μ; length of esophagus, 76 to 87μ; length of tail, 45 to 56μ; a, 34 to 40; β, 7.8 to 8.7; γ, 12.5 to 15.5. ♀: Length, 930μ to 1 mm; width, 25 to 30μ; length of esophagus, 84 to 93μ; length of tail, 92 to 104μ; a, 31 to 39; β, 10 to 11.2; γ, 9 to 10; V, 70 to 74%.

Description.—Cuticular striae fine, moderately obscure. Head region (Fig. 2,A) set off about as in *A. parietinus*, lip-like elevations relatively conspicuous. Stylet 14 to 16μ long in males, 16 to 19μ long in females; without basal knobs. Excretory pore opposite posterior end of esophageal bulb. Tail of female long and slender, tapering more or less evenly. Postvulvar uterine sac usually extending about one-half distance from vulva to anus but somewhat variable in size and shape. Ovary outstretched and extending past posterior end of esophageal glands, sometimes nearly to nerve ring. Tail of male (Fig. 2,B) somewhat similar in shape to that of female but tapering less abruptly in anterior two-thirds, then narrowing abruptly with posterior third in the form of a more or less slender terminal spike. Four pairs of papillae present; one pair about 8 to 10μ in front of anus and nearly ventral, one pair opposite or slightly posterior to anus, and 2 pairs, 4 or 5μ apart, near middle of tail. Spicule 18 to 20μ long with shape as shown in Figure 2,B.

Habitat.—Soil.

Locality.—Islands of Oahu and Maui, Territory of Hawaii, U.S.A.

Comparisons and affinities.—The writer's material agreed fairly closely with both de Man's and Goodey's descriptions. The most conspicuous difference was the length of the stylet which, in females, measured only 16 to 19μ as against 24 to 27μ in de Man's material.

A. elmiraensis resembles *A. tenuicaudatus* more closely than it resembles any other described species. It differs in the length of the tail in both sexes and in the length of the stylet. The stylet is only 10μ long and γ, in the female, is about 4.5, while in the male tail of *A. elmiraensis* the terminal portion posterior to the papillae is considerably longer than in *A. tenuicau-*

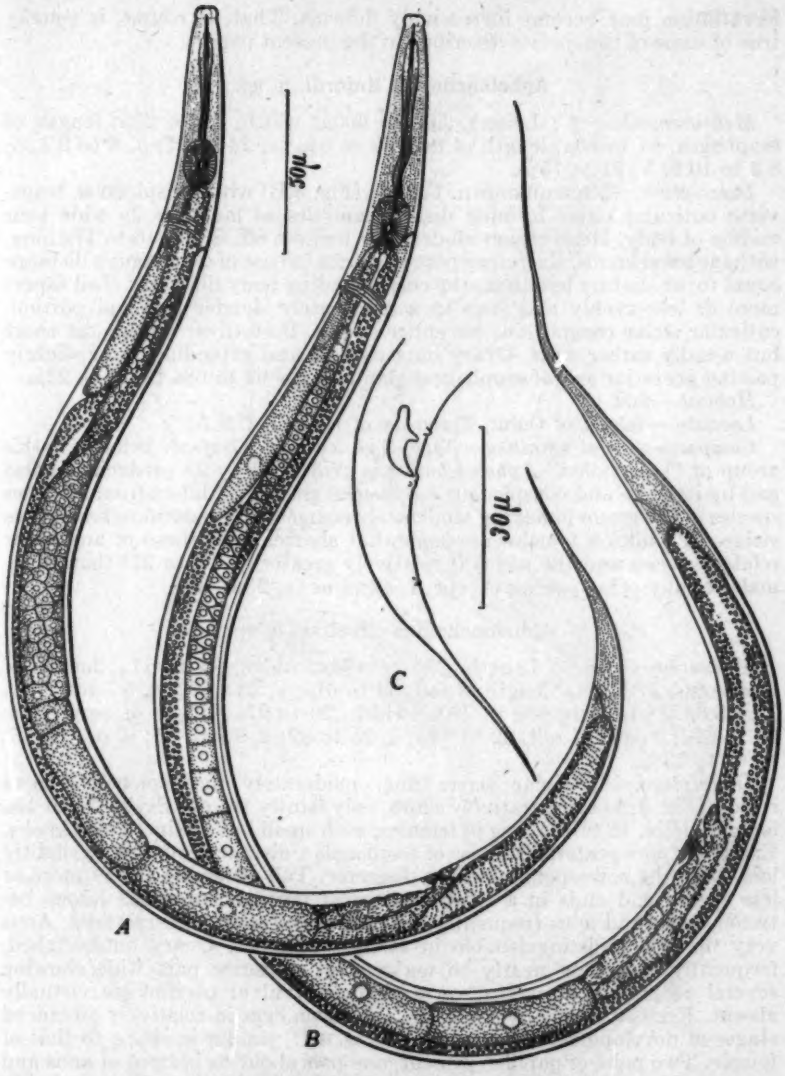

Fig. 1. A.—*Aphelenchoides oliveirae*, n.sp., female. B.—*A. winchesi* var. *filicaudatus*, n. var., female. C.—*A. oliveirae*, n.sp., tail of male.

datus. In fact the tail of the female of *A. elmiraensis* approaches in length that of *A. longicaudatus* being about 1½ times as great as the distance from vulva to anus. Van der Linde was probably justified in regarding *A. elmiraensis* as a distinct species but as other populations become known its dif-

ferentiation may become increasingly difficult. That, of course, is equally true of some of the species described in the present paper.

Aphelenchoides linfordi, n. sp.

Measurements.—♂ : Length, 500 to 600μ; width, 20 to 23μ; length of esophagus, 61 to 66μ; length of tail, 52 to 64μ; a, 24 to 27; β, 8 to 9.3; γ, 8.3 to 10.9; V, 71 to 75%.

Description.—Male unknown. Female (Fig. 3,B) with conspicuous, transverse cuticular striae forming distinct annules as much as 2μ wide near middle of body. Head region moderately well set off. Stylet 16 to 17μ long, without basal knobs. Excretory pore posterior to base of esophagus a distance equal to, or slightly less than, the corresponding body diameter. Tail tapers more or less evenly and ends in a moderately slender terminal portion, cuticular striae conspicuous for entire length. Postvulvar uterine sac short but usually rather wide. Ovary outstretched and extending to or slightly passing posterior end of esophageal glands. Eggs 62 to 68μ by 21 to 22μ.

Habitat.—Soil.

Locality.—Island of Oahu, Territory of Hawaii, U.S.A.

Comparisons and affinities.—That *Aphelenchoides linfordi* belongs to this group of "long tailed" *Aphelenchoides* is evidenced by its predacious habit and by its large and conspicuous esophageal glands. It differs from all other species of the group in having moderately coarse and conspicuous transverse striae. In addition females are somewhat shorter than those of any other related species and the width is relatively greater (a, 24 to 27) than in females of any other species except *A. oliveirae* (a, 25 to 32).

Aphelenchoides oliveirae, n. sp.

Measurements.—♂: Length, 384 to 484μ; width, 13 to 17μ; length of esophagus, 57 to 64μ; length of tail, 54 to 61μ; a, 28 to 32; β, 6.7 to 7.9; γ, 7 to 8.6. ♀ : Length, 600 to 720μ; width, 20 to 27μ; length of esophagus, 60 to 67μ; length of tail, 82 to 94μ; a, 25 to 32; β, 9.2 to 11; γ, 6.7 to 8.5; V, 69 to 73%.

Description.—Cuticular striae fine, moderately inconspicuous. Head region (Fig. 1,A) comparatively short, only faintly set off. Stylet 14 to 15μ long in males, 15 to 16μ long in females, with small but distinct basal knobs. Excretory pore posterior to base of esophagus a distance equal to, or slightly less than, the corresponding body diameter. Tail of female tapers more or less evenly and ends in a slender terminal portion. Intestinal lumen between vulva and anus frequently wide and filled with fecal material. Anus very minute, indistinguishable in many specimens. Ovary outstretched, frequently extending nearly to nerve ring; posterior part wide showing several oöcytes in a given cross section. Postvulvar uterine sac virtually absent. Eggs 70 to 83μ by 18 to 19μ (based on eggs in relatively advanced stages of development). Tail of male (Fig. 1,C) similar in shape to that of female. Two pairs of papillae present, one pair about 8μ in front of anus and one pair about 18μ posterior to anus; a pair of adanal papillae probably present. Spicule about 14μ long and shaped as shown in Figure 1,C.

Habitat.—Soil.

Locality.—Island of Maui, Territory of Hawaii, U.S.A.

Comparisons and affinities.—This species differs from *A. demani* in having a shorter tail in both sexes. In his original description of *A. demani* Goodey

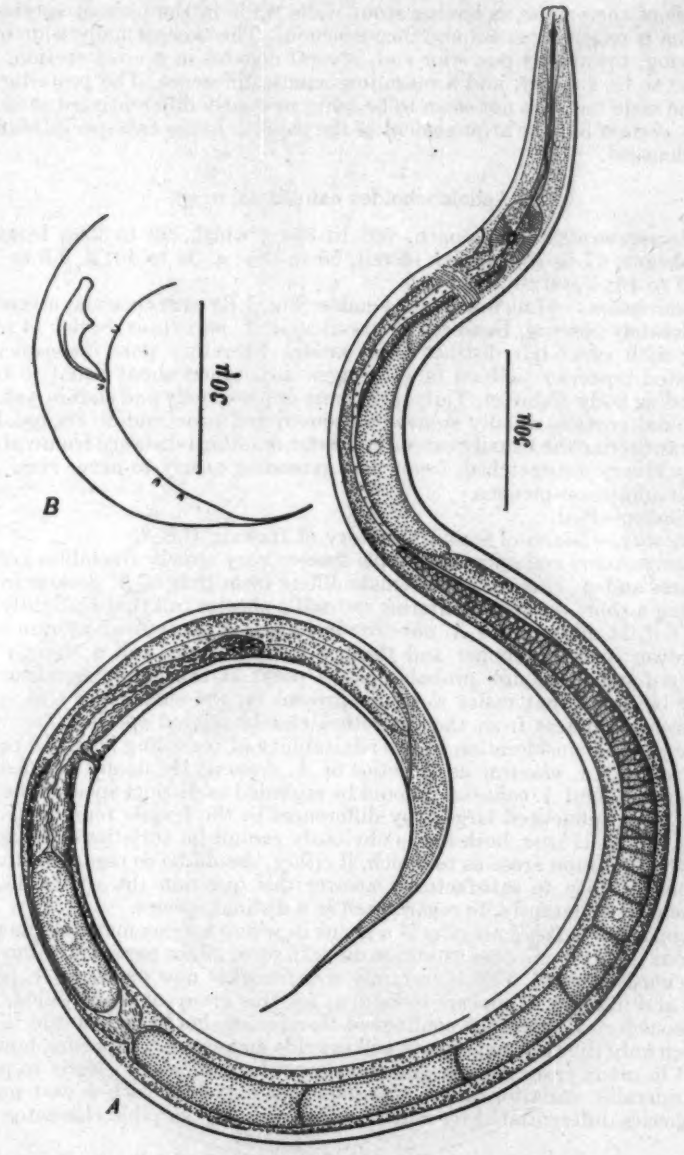

Fig. 2. A.—*Aphelenchoides tenuicaudatus*, female.
B.—*A. tenuicaudatus*, tail of male.

writes of the vagina as having stout walls while in the present species the vagina is relatively small and inconspicuous. The exceptionally wide ovary showing, toward its posterior end, several oöcytes in a cross section, may prove to be another, and a more important, difference. The posterior half of the male tail does not seem to be quite so clearly differentiated as in that of *A. demani* but the arrangement of the papillae in the two species seems to be identical.

Aphelenchoides oahuënsis, n. sp.

Measurements.— ♀ : Length, 760 to 860μ; width, 20 to 22μ; length of esophagus, 67 to 76μ; length of tail, 55 to 66μ; a, 35 to 40; β, 9.6 to 11.9; γ, 13 to 15; V, 69 to 75%.

Description.—Male unknown. Female (Fig. 3,B) with cuticular striae fine, moderately obscure. Head set off about as in *A. parietinus*. Stylet 14 to 15μ long with small but distinct basal knobs. Excretory pore inconspicuous, situated posterior to base of esophagus a distance about equal to corresponding body diameter. Tail tapers more or less evenly and ends in a slender terminal portion usually somewhat constricted near middle region. Postvulvar uterine sac usually extending about one-third distance from vulva to anus. Ovary outstretched, frequently extending nearly to nerve ring. Anus small and inconspicuous.

Habitat.—Soil.

Locality.—Island of Oahu, Territory of Hawaii, U.S.A.

Comparisons and affinities.—This species very closely resembles both *A. demani* and *A. oliveirae*. The female differs from that of *A. demani* in possessing a short postvulvar uterine sac and a shorter tail that is slightly constricted. It differs from *A. oliveirae* in having a postvulvar uterine sac, a narrower ovary, a longer and thinner walled uterus and a slightly constricted tail. Although probably not a point of taxonomic significance it may be noted that males were not present on the cultures of this species whereby it differs from the two other closely related species. The writer gave careful consideration to the advisability of regarding both the present species and *A. oliveirae* as varieties of *A. demani*. He finally decided that *A. oliveirae* and *A. oahuënsis* should be regarded as distinct species, the decision being influenced largely by differences in the female reproductive organs. If this is true, both forms obviously cannot be varieties of *A. demani* and the question arose as to which, if either, should be so regarded. In view of his inability to satisfactorily answer this question the writer decided, somewhat reluctantly, to regard each as a distinct species.

Apparently *Aphelenchoides* is a genus in which a great many of the populations that come to ones attention differ in some minor particular from those previously studied. This is certainly true for what now passes as *A. parietinus* and likewise it appears to be true for this group of "long-tailed," predaceous forms. What the confines of the species should be is a question for which only time and experience will provide an answer. It appears, however, that in many cases specific diagnoses must be sufficiently elastic to permit considerable variation or we will soon find ourselves with a vast number of species differentiated by minor and exceedingly variable characters.

As males are known for only part of the species the following key is based on the females. Information regarding the male tail is supplementary and is included for convenience in the hope that it may, at times, prove useful.

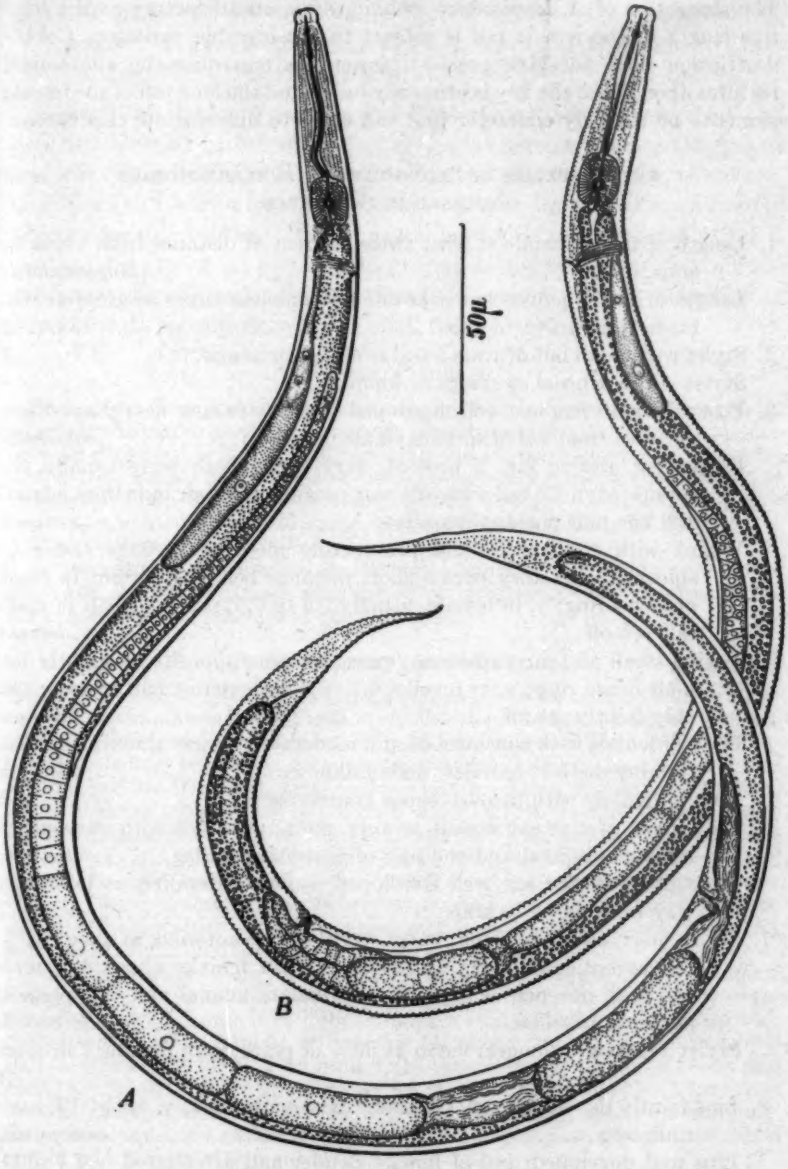

Fig. 3. A.—*Aphelenchoides oahuënsis*, n. sp. female.
B.—*A. linfordi*, n. sp., female.

The separation of *A. longicaudatus* obviously is unsatisfactory as the relative length of the female tail is subject to considerable variation. Cobb's description does not give precise information regarding the anatomical features upon which the key is primarily based and the long tail of the female seems to be the only character that can serve to differentiate this species.

KEY TO SPECIES OF "LONG-TAILED" APHELENCHOIDES DISCUSSED IN THIS PAPER

1. Length of tail in female at least twice as great as distance from vulva to anus ..... *longicaudatus*
   Length of tail in female not over one and one-half times as great as distance from vulva to anus 2
2. Stylet with small but distinct basal swellings or knobs 3
   Stylet without basal swellings or knobs 5
3. Postvulvar uterine sac well developed often extending nearly one-third distance from vulva to anus; male unknown ..... *oahuënsis*
   Postvulvar uterine sac, if present, very short; both sexes usually encountered; male tail with one pair preanal, one pair indistinct adanal and one pair postanal papillae 4
4. Vagina with stout walls and presumably moderately large and conspicuous; excretory pore a short distance behind bulb but in front of nerve ring; γ, in female, usually 5.3 to 6.5; posterior half of male tale set off ..... *demani*
   Vagina small and inconspicuous; excretory pore opposite or slightly behind nerve ring; γ, in female, 6.7 to 8.5; posterior half of male tail only faintly set off ..... *oliveirae*
5. Body of female with conspicuous and moderately coarse transverse striae forming distinct annules; male unknown ..... *linfordi*
   Body of female with inconspicuous transverse striae 6
6. Postvulvar uterine sac absent or very short; male tail with one pair of indistinct adanal and one pair of postanal papillae ..... *winchesi*
   Postvulvar uterine sac well developed usually extending at least half way from vulva to anus 7
7. Stylet short, about 10μ long; vulva relatively far anteriad, at about 62%; tail exceptionally long and slender, γ, in female, about 4.5; male tail with one pair of preanal, one pair of adanal and two pairs of postanal papillae ..... *elmiraensis*
   Stylet 14μ long or longer; vulva at 66% or more; γ, in female, 7 or more 8
8. Lips faintly developed; tail of female relatively short, γ, about 12; male unknown ..... *oswegoensis*
   Lips well developed; tail of female slender and attenuated, γ, 7.7 to 11; male with one pair preanal, one pair indistinct adanal and two pairs of postanal papillae ..... *tenuicaudatus*

MALACOLOGY.—*A new* Nenia *from Haiti and some notes on this genus.*[1] HARALD A. REHDER, U. S. National Museum. (Communicated by PAUL BARTSCH.)

Since 1786, when *Nenia tridens* Schweigger was first figured and described, albeit rather inadequately, no other member of this genus has turned up from the West Indian region. The discovery, therefore, of a species of *Nenia* from the southern peninsula of Haiti is a matter of considerable interest. The characters of this form are such that it can not be placed in any of the groups hitherto erected within the subfamily Neniinae, and I am therefore forming a new subgenus of *Nenia* for its reception, which I shall call:

Nenisca, n. subgen.

Shell of medium size, entire, fusiform, with fine, crowded, axial wrinkles which are irregular and anastomosing. Aperture large, dark inside, with a broadly expanded peristome. Superior lamella not continuous with the spiral lamella but widely discontinuous, the spiral lamella revolving peripherad of the superior lamella, its anterior end curving strongly towards the superior lamella, which continues for some distance beyond it. Lunella absent.

Type.—*Nenia* (*Nenisca*) *bartschi*, new species.

In the relation of the spiral and superior lamellae, this group approaches *Steeriana* Jousseaume, from which it differs greatly in external appearance. Its anastomosing sculpture is quite distinct.

Nenia (Nenisca) bartschi, n. sp. Figs. 1–5

Shell of medium size, rather solid, fusiform, with an entire and attenuate apex. Nuclear whorls 2, light red-brown in color, the first 1¾ whorls smooth, the last ¼ with rude axial riblets. The 6 postnuclear whorls are chestnut-brown in color, becoming deep purplish brown behind the aperture, and are marked by irregular, axial yellowish-ivory-white flammulate patches, which coalesce towards the top of each whorl; a row of small spots of chestnut brown, the ground color, is present just below the suture. The sculpture consists of fine, crowded, irregular, axial riblets, which anastomose and divaricate. The last whorl is the broadest, the penultimate whorl only slightly less in diameter; the whorls moderately convex, with an impressed suture. The aperture is rather large, ovate, dark chestnut-brown within, surrounded by a broad, expanded white peristome.

Superior lamella strong, convex on the left side, the lower end of the spiral lamella peripherad of and curving toward the former, the lamellae overlapping for about 1.5 mm. The inferior lamella stout, the free edge thickened, continuing as a low lamella on the axis for about one whorl. The principal palatal fold begins about 1.5 mm in from the peristome on the left side, and runs parallel with the suture for about 6 mm on the dorsal side. A lunella is absent. The subcolumellar lamella is typical, ascending, about 3.5 mm long. The clausilium has a rather long pedicle, and an elongate spatula, the distal end of which is bluntly pointed.

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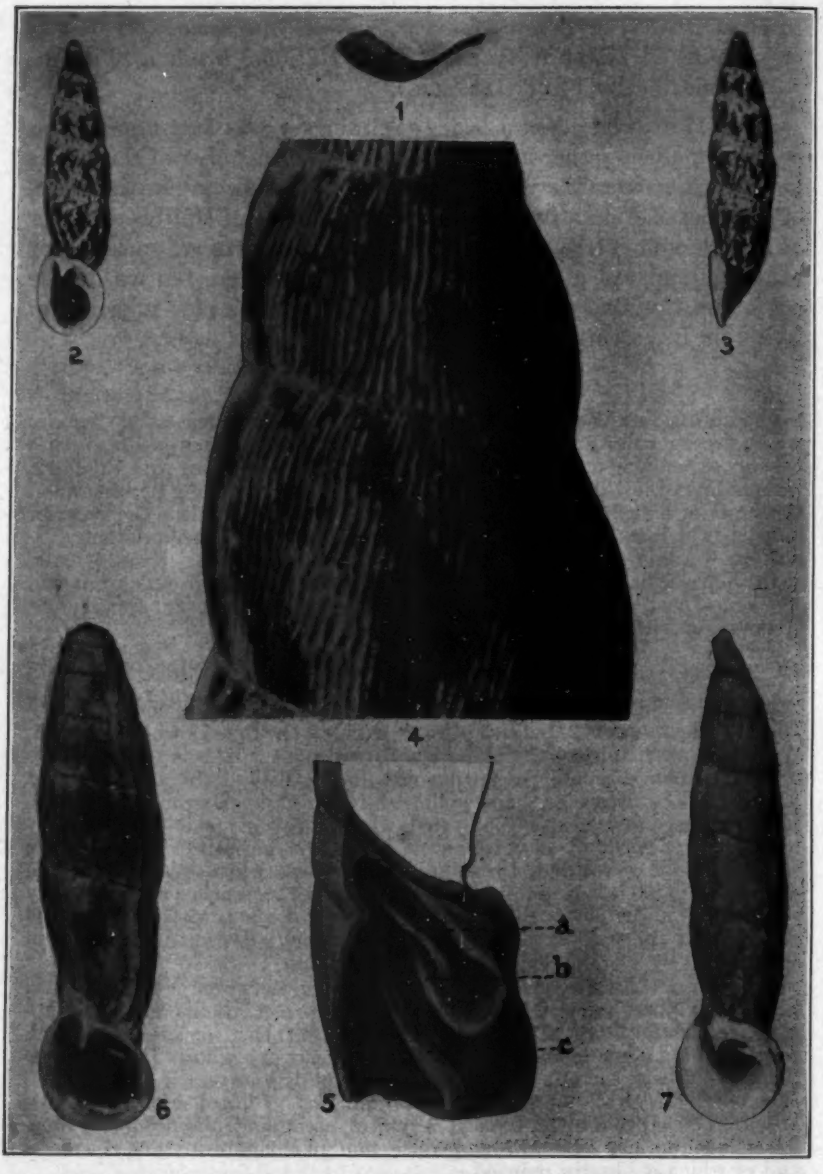

Figs. 1–5.—*Nenia* (*Nenisca*) *bartschi*, n. sp. 1, Clausilium. 2–3, Shell ×2. 4, Detail of sculpture ×15. 5, Detail showing lamellae: *a*, spiral lamella; *b*, superior lamella; *c*, inferior lamella. Fig. 6.—*Nenia* (*Paranenia*) *perarata* v. Martens. Shell ×3. Fig. 7.—*Nenia* (*Nenia*) *tridens* Schweigger. Shell ×3.

The type, U.S.N.M. Cat. No. 380074, was collected by William J. Eyerdam at 1,000 meters altitude on the top of Mt. Rochelle (or Rochelois), south of Rochelois, Dept. du Sud, Haiti. It has 8 whorls and measures: Length 22.6 mm; diameter 5 mm; height of aperture 6.3 mm, width of aperture 4.9 mm.

Four other specimens, U.S.N.M. Cat. No. 499244, come from the same lot.

Two bleached specimens and a few fragments, U.S.N.M. Cat. No. 403023, of what appears to be this species were collected by Charles R. Orcutt on the estate of the Haitian American Sugar Company, just north of Port-au-Prince, where they were probably washed down from the mountains southeast of the city.

I dedicate this interesting species to Dr. Paul Bartsch, who through his cruises throughout the West Indies, and consequent systematic studies, has done much to elucidate the terrestrial malacological fauna of the Antillean region.

The only other West Indian *Nenia* is, as is well known, the Puerto Rican *Nenia tridens* Schweigger, the sole representative of the typical subgenus *Nenia*. This group is distinguished by its lack of a lunella, by the thickened peristome and by the peculiar sculpture and apical character; the embryonic shell, generally lost, is slender and set at an angle on the succeeding whorl. (fig. 7).

Paranenia, n. subgen.

Shell rather stout, with an entire blunt, rounded apex. Sculpture consisting of strong, oblique, broad, rounded, moderately distant ribs, crossed obliquely by fine growth lines. A lunella is present.

Type.—Nenia perarata von Martens.

Nenia perarata von Martens (fig. 6) from Colombia has been placed in *Nenia* on account of its rather similar sculpture, but it does not have the narrower, decollate apex of *Nenia tridens* Schweigger, and it possesses a lunella. These important differences, as well as its quite distinct geographic range, merit its being placed in a separate subgenus.

MALACOLOGY.—*A new intermediate host of the Asiatic blood fluke,* Schistosoma japonicum *Katsurata.*[1] PAUL BARTSCH, U. S. National Museum.

Dr. Y. T. Yao has sent to the United States National Museum a large series of *Oncomelania* for determination, which he collected at Wang Ling Hsiang, Pingyang Hsien, in the central part of Kwangsi Province, China, which he found served as intermediate hosts of the Asiatic Blood Fluke in that region. These proved to be an undescribed species of *Oncomelania,* which I take pleasure in naming for its discoverer.

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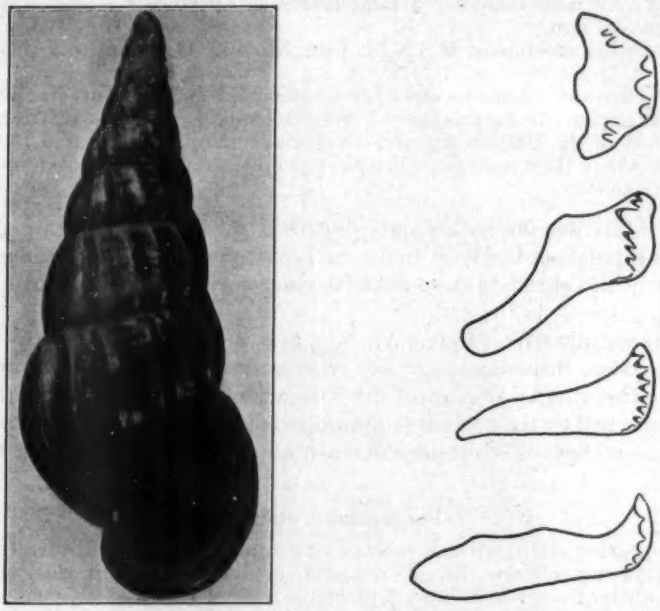
This find extends the range of the genus *Oncomelania* considerably farther south than heretofore known.



Figs. 1–2.—*Oncomelania yaoi*, n. sp. 1, shell, ×10. 2. radula.

Oncomelania yaoi n. sp.

Shell elongate-conic; early whorls pinkish, the rest wax yellow, translucent, shining, with the edge of the peristome tinged with a dusky suffusion. Nuclear whorls 2, well rounded smooth, excepting microscopic granulations. Postnuclear whorls slightly rounded, almost flattened; the first smooth, the second showing in its distal part the beginning of axial ribs, which on the succeeding turns become very strongly developed. These ribs are rather distantly spaced, i.e., they are about one-half as wide at their base as the spaces that separate them. Of these ribs 15 are present on all the turns but the last, which has 12. On the last whorl there is a very heavy varix a little distance behind the peristome. The axial ribs and intercostal spaces are marked by fine wavy hairlike incremental lines. Suture well impressed. Periphery well rounded. Base short, well rounded, marked by the continuation of the sculpture of the spire, but here the axial ribs become enfeebled and evanesce as they pass into the narrow umbilicus. Aperture ovate, somewhat oblique and effuse, and expanded at the junction of the basal and columellar angle, appressed to the preceding turn at the parietal wall. Operculum thin, corneous paucispiral, having 2.2 whorls and an excentric nucleus. The radula has the formula: $\frac{1\text{–}1\text{–}1}{2\text{–}2}$, 2:1:3, 8, 5.

The type, U.S.N.M. no. 469149, has 9.2 whorls and measures: Length, 8.8 mm; greater diameter, 3.8 mm; lesser diameter, 3.3 mm. The rest bear the number 469150.

Its almost flattened whorls, brilliant translucent wax color with pinkish early whorls, heavy distantly spaced, axial, ribs and peculiar radula formula easily distinguish it from all the known species of *Oncomelania*.

MAMMALOGY.—*Two new pocket gophers of the genus* Heterogeomys *from Mexico.*[1] E. A. GOLDMAN, Bureau of Biological Survey.

In connection with a group alignment of the forms of the genus *Heterogeomys* by E. W. Nelson and the writer four new subspecies were described (Proc. Biol. Soc. Washington, vol. 42, pp. 147–152, March 30, 1929). A more critical examination and further consideration of material available have resulted in the segregation of two additional forms, as follows:

Heterogeomys hispidus tehuantepecus, subsp. nov.

Tehuantepec Pocket Gopher

Type.—From mountains 12 miles northwest of Santo Domingo and about 60 miles north of Tehuantepec City, Oaxaca, Mexico (altitude 1,600 feet). No. 73434, ♂ adult, skin and skull, U. S. National Museum (Biological Survey collection); collected by Nelson and Goldman, June 18, 1895. Original number 8092.

Distribution.—Known only from the type locality in the mountains near the top of the continental divide on the southern side of the Isthmus of Tehuantepec.

General characters.—Most closely resembling *Heterogeomys hispidus hispidus* from near Jalapa, Vera Cruz; size similar, but color lighter, near "mars brown" instead of "seal brown" (Ridgway, 1912); differing also in cranial details, including more highly arched rostrum. Similar in general to *Heterogeomys hispidus isthmicus* of Gulf coast plain on northern side of Isthmus of Tehuantepec, but color somewhat darker, near "mars brown" instead of "chestnut brown"; skull differing most notably in less deeply sinuous lambdoid crest. Similar in general size to *Heterogeomys hispidus chiapensis* of high mountains of central Chiapas, but color light, near "mars brown" instead of "seal brown"; pelage coarser and thinner; skull heavier and quite different in detail.

Color.—Type (acquiring fresh pelage): Head and anterior upper parts "mars brown" in fresh pelage, becoming "chestnut brown" in worn pelage on posterior part of back, flanks, and limbs; under parts thinly haired, "cinnamon brown"; feet scantily covered with brownish hairs; tail nearly naked near base, becoming entirely bare near tip, the dried skin dark brown.

Skull.—Most closely resembling that of *hispidus*, but nasals more highly arched, less flattened posteriorly; frontal region less depressed anteriorly; jugal narrower, more evenly rounded anteriorly at union with maxilla; auditory bullae less inflated, not usually projecting below plane of lower

[1] Received January 27, 1939.

surface of basioccipital (usually projecting below this plane in *hispidus*); molariform toothrows shorter. Very similar in general form to that of *isthmicus*, but lambdoid crest much less deeply sinuous, a slight concavity representing the abrupt crescentic median deflection forward present in *isthmicus* as viewed from above; nasals less flattened, rising more prominently above level of premaxillae; maxillary arm of zygoma lighter, encroaching less deeply on premaxillae which are correspondingly broader posteriorly; dentition about the same. Compared with that of *chiapensis* the skull is similar in general size, but heavier in structure; rostrum broader; interorbital region narrower, the frontal surface less even, more concave near median line and rising higher anteriorly; maxillary arm of zygoma encroaching farther on premaxillae which are correspondingly reduced in width posteriorly; auditory bullae larger; palatopterygoids broader; dentition heavier.

Measurements.—Type: Total length, 332 mm; tail, 102; hind foot, 48. Two adult female topotypes, respectively: 348, 306; 94, 81; 51, 41. *Skull* (type [♂] and an adult female topotype, respectively): Occipitonasal length, 61.7, 61.4; zygomatic breadth, 39.2, 40.8; breadth across squamosals (over mastoids), 38.2, 39.6; interorbital constriction, 10.7, 10.8; length of nasals, 23.9, 24.2; maxillary toothrow (alveoli), 13, 13.3; width of upper incisors (cutting edge), 8.5, 8.7.

Remarks.—The resemblance of *tehuantepecus* to typical *hispidus* suggests that there may be some connection between the two through the mountains of the interior, but intergradation is also probable with the near geographic neighbor *isthmicus* of the Gulf coastal plains. In the genus *Heterogeomys*, as in other pocket gophers, the males are usually larger than the females, but in the present form an adult female slightly exceeds the type, a male of about the same age.

Specimens examined.—Eight, all from the type locality.

Heterogeomys hispidus teapensis, subsp. nov.

Tabasco Pocket Gopher

Type.—From Teapa, Tabasco, Mexico. No. 100035, ♀ adult, skin and skull, U. S. National Museum (Biological Survey collection); collected by Nelson and Goldman, March 23, 1900. Original number 14056.

Distribution.—Lowlands and lower mountain slopes in southern Tabasco.

General characters.—A large subspecies, similar to *Heterogeomys hispidus chiapensis* of high mountains of central Chiapas, but color light, near "mars brown" instead of "seal brown"; pelage coarser and thinner; skull more elongated. Similar to *Heterogeomys hispidus isthmicus* of coastal plain in Vera Cruz on north side of Isthmus of Tehuantepec, but color somewhat darker, the upper parts near "mars brown" instead of "chestnut brown"; skull longer, with lambdoid crest less deeply sinuous. Somewhat like *Heterogeomys hispidus yucatenensis* of the Yucatan peninsula, but larger and slightly darker; skull with more elongated rostrum.

Color.—Type (acquiring fresh pelage): Upper parts in general near "mars brown"; under parts and limbs nearly naked, the scattered hairs light brownish; tail bare, the dried skin brownish.

Skull.—Similar to that of *chiapensis* but longer, with narrower zygomata; rostrum and nasals longer; dentition heavier, the incisors decidedly broader.

Differing from that of *yucatenensis* in decidedly larger size, greater elongation of rostrum, and much heavier dentition. Compared with that of *isthmicus* the skull is longer, the lengthening mainly in rostrum; zygomata actually as well as relatively narrower; nasals longer; lambdoid crest less deeply sinuous; dentition similar.

Measurements.—*Type*: Total length, 338 mm; tail, 91; hind foot, 48.5. An adult female topotype: 334; 90; 46. *Skull* (type [♀] and an adult female topotype, respectively): Occipitonasasl length, 61.3, 59; zygomatic breadth, 36, 37; breadth across squamosals (over mastoids), 36.3, 36; interorbital constriction, 10.3, 10.8; length of nasals, 24.8, 24; maxillary toothrow (alveoli), 15, 13.4; width of upper incisors (cutting edge), 8.5, 8.3.

Remarks.—Specimens from low elevations in Tabasco were referred by Nelson and the writer (Proc. Biol. Soc. Washington, vol. 42, p. 152, March 30, 1929) to *chiapensis* of the high mountains of central Chiapas, although some differences were pointed out. More critical examination seems to warrant their segregation as a geographic race.

Specimens examined.—Total number, five, all from Tabasco, as follows: Montecristo, 2; Teapa (type locality), 3.

ORNITHOLOGY.—*Two new races of birds from the Indo-Chinese sub-region.*[1]

H. G. DEIGNAN, U. S. National Museum. (Communicated by H. FRIEDMANN.)

A recent visit by the writer to the American Museum of Natural History and the Academy of Natural Sciences of Philadelphia has shown that two more Siamese birds must be granted subspecific recognition. For the loan of their material, thanks are hereby expressed to the authorities of the institutions named.

Cyanops incognita euroa, subsp. nov.

Type.—Adult male, U. S. National Museum no. 337073; collected at Khao Sa-bap, Chantabun province, S.E. Siam, 28 April, 1937, by H. G. Deignan.

Subspecific characters.—Adults of the new form are readily distinguishable from adults of typical *incognita* (Tenasserim) by the greater size of the red patch on the hind-crown (covering at least twice as large an area as in *incognita*), and by the paler turquoise-blue of the throat. Seventeen adults of *euroa* have been compared with four adults of *incognita*.

Range.—South-eastern Siam, Cambodia, Laos, and Tongking.

Napothera crispifrons calcicola, subsp. nov.

Type.—Adult male, U. S. National Museum no. 332024; collected at Hin Lap, East Siam, 8 December, 1931, by Dr. Hugh M. Smith.

Subspecific characters.—From *N. cr. annamensis*, distinguished at once by complete absence of slaty color, above and below. From typical *crispifrons*, it may be known by its having the broad shaft-streaks of the throat

[1] Published by Permission of the Secretary of the Smithsonian Institution. Received February 9, 1939.

black instead of dark brown, affording a stronger contrast with the white portion of the feathers; by having a distinct rufous area on each side of the neck between the white throat and the rufous-washed ear-coverts; by having the dark edgings of the feathers of crown and mantle obsolete, giving the upperparts a more uniform aspect and causing the gray shafts to stand out more boldly. Three specimens of *calcicola* have been compared with four specimens of *annamensis* and seven specimens of *crispifrons*.

Range.—Eastern Siam.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

41ST ANNUAL MEETING

The 41st Annual Meeting of the Washington Academy of Sciences was held in the Assembly Hall of the Cosmos Club, January 19, 1939, with 55 members present. President PAUL HOWE called the meeting to order at 9.20 P.M.

The minutes of the 40th Annual Meeting were presented as published in the Journal and were approved as published.

The Corresponding Secretary, NATHAN R. SMITH, submitted the following report on the membership and activities of the Academy:

Membership: during 1938, 41 were elected to resident and 1 to non-resident active membership. Of these, 40 have qualified for resident membership. The non-resident member was recently elected and has not replied to date. Five were elected in recognition of their work in Chemistry, and also five in Botany; four each in Engineering, Protozoology, and Biology; three each in Physics, Medicine, Forestry, and Mycology; two in Anthropology; and one each in Geology, Bacteriology, Genetics, and Soil Science. There were two resignations (1 resident and 1 non-resident) and ten deaths (7 resident and 3 non-resident). Seven were transferred from resident to non-resident and one from non-resident to resident membership. Six resident and one non-resident member retired from professional work during the year and were retained as active members without the payment of dues.

On January 1, 1939, the membership, therefore, consisted of 11 Honorary Members, 3 Patrons, and 554 Active Members, of which 2 are Life Members. Of the 554 active members, 33 do not pay dues because of retirement from professional work (27 resident and 6 non-resident). There are, therefore, 521 active members who should pay dues, 391 resident and 130 non-resident. Since the number of resident active members is limited to 400 and the non-resident to 200, there were 9 vacancies in the resident and 70 vacancies in the non-resident active membership. The status of the resident active membership as regards number is very satisfactory owing to the efficiency of the Membership Committee. The non-resident class is still very unsatisfactory, although slightly better than last year.

The deaths of the following members are reported at this time:

GEORGE BIRD GRINNELL, non-resident, April 11, 1938.
MAURICE C. HALL, resident, May 1, 1938.
FREDERICK I. ALLEN, non-resident, May 17, 1938.
TRUMAN MICHELSON, resident, July 26, 1938.
EARL B. MCKINLEY, resident, July 29, 1938.

GUY N. COLLINS, resident, August 14, 1938.
VICTOR K. CHESNUT, resident, August 29, 1938.
WILLIS R. GREGG, resident, September 14, 1938.
GIUSEPPI STEFANINI, honorary, September 15, 1938.
CHARLES E. MONROE, honorary, December 7, 1938.

The Board of Managers held seven meetings during the year with an average attendance of 17. Two special committees were appointed, one on the format of the Journal and the other on the Financial Status of the Journal. The report of each committee has been accepted by the Board. Dr. A. L. DAY was appointed a delegate to the dedication of the Franklin Institute as a Memorial to Benjamin Franklin. The Institute awarded a Certificate of Appreciation to the Academy for this action.

On motion it was voted to accept the Corresponding Secretary's report and to place it on file.

The Recording Secretary presented the following report:

The 41st year of the Academy began with the 284th meeting and ended tonight with the 289th meeting.

The 284th meeting was held in the Assembly Hall of the Cosmos Club on February 17, 1938. The address was given by CHARLES THOM, the retiring President of the Academy, on the subject *A Microbiologist Digs in the Soil.* Attendance about 75.

The 285th meeting was held in the Assembly Hall of the Cosmos Club on March 17, 1938. The address was given by A. K. BALLS of the Bureau of Chemistry and Soils on the subject *Some Modern Aspects of Enzyme Catalysis.* Attendance about 70.

The 286th meeting was held in the Auditorium of the National Museum on April 21, 1938. The address of the evening was given by MARIUS BARBEAU, the Dominion Ethnologist of Canada, on the subject *How Totem Poles Originated.* The address was illustrated by motion pictures, slides and by Indian songs with drums. Attendance about 125.

The 287th meeting was held in the Assembly Hall of the Cosmos Club on November 17, 1938. The address on the subject *Cancer and Cooperative Research* was given by R. R. SPENCER, National Cancer Institute of the National Institute of Health. Attendance about 50.

The 288th meeting was held in the Assembly Hall of the Cosmos Club on December 15, 1938. An illustrated address was given by F. H. H. ROBERTS, JR., on the subject *The Folsom Problem in American Archeology.* Attendance about 55.

The 289th meeting of the Academy was held on January 19, 1939, in the Assembly Hall of the Cosmos Club with 85 persons present. The address of the evening was given by PAUL E. HOWE, the retiring President of the Academy on the subject *Some Problems in Attaining Adequate Nutrition.* This was the final meeting of the 41st year of the Academy.

On motion it was voted to accept the Recording Secretary's report and to place it on file.

The report of the Treasurer, H. G. Avers, was read by Howard S. Rappleye:

CASH RECEIPTS AND DISBURSEMENTS

RECEIPTS

From Back dues	$ 110.00
From Dues for 1938	2,425.10
From Dues for 1939	30.00

From Life Membership (L. H. James)	72.24	
From Subscriptions for 1938	836.40	
From Subscriptions for 1939	337.80	
From Sales of Journals	167.34	
From Payments for reprints	172.54	
From Sales of 1937 Directory	2.80	
From Interest on Deposits	55.45	
From Interest on Investments	1,085.10	
Total receipts	5,294.77	
Cash Balance January 1, 1938	8,807.11	
To be accounted for		$14,101.88

DISBURSEMENTS

For Secretary's Office, 1937		$ 97.85	
For Secretary's Office, 1938		171.90	
For Treasurer's Office		202.52	
For Journal Printing, 1937		276.82	
For Journal Printing, 1938		2,455.92	
For Journal Reprints, 1937		56.26	
For Journal Reprints, 1938		355.71	
For Journal Office, 1937		50.65	
For Journal Office, 1938		9.60	
For Journal Illustrations		281.57	
For Meetings Committee, 1937		58.35	
For Meetings Committee, 1938		223.60	
For Membership Committee, 1937		4.00	
For Dues of Retired Member returned		5.00	
Bank Debit Memos, as follows:—			
Reprints	$12.61		
Dues	10.35		
Subscription	.11	23.07	
Deposited in Savings Account		8,314.12	
Total disbursements		12,586.94	
Cash Balance December 31, 1938		1,514.94	
Total			$14,101.88

RECONCILIATION OF BANK BALANCE

Balance as per Cash Book, December 31, 1938			$ 1,514.94
Bank Balance, American Security & Trust Co. as per statement of December 31, 1938		$ 1,696.44	
Checks outstanding, not cashed:			
No. 170	$ 21.50		
No. 503	160.00		
Total		181.50	
Balance			$ 1,514.94

Check No. 170 listed as outstanding, was issued in May, 1934, but has not been cashed.

INVESTMENTS

409 Shares stock of Washington Sanitary Improvement Co., par value $10 per share, cost	$ 4,090.00
20 Shares stock Potomac Electric Power Co., 6% Pref.; cost	2,247.50
1 Bond of Interborough Rapid Transit Co. No. 37020, interest at 5%; due Jan. 1966; par value $1000; cost	995.00
*1 Bond of Chicago Railways Co. No. 1027; interest at 5%; due 1927; par value $1000 less $250; cost	713.87
1 Real Estate note of T. Q. Donaldson (No. 6 of 12) dated June 26, 1937 for 3 years; interest at 5%; cost	1,000.00
2 Real estate notes of Yetta Korman et als., dated Oct. 5, 1938 for 3 years; (No. 7 of 37 for $500, and No. 8 of 37 for $500); interest at 5%; cost	1,000.00
3 Real estate notes of Ell & Kay Bldg. & Investment Co. dated Oct. 15, 1938 for 3 years; (No. 75 of 165 for $2000, No. 83 of 165 for $1000, and No. 101 of 165 for $1000); interest at 5%; cost	4,000.00
Butler notes—Property at 1707 L St., N. W. bought in by note holders—Academy's share 4/250ths; Interest amounting to $20 received in 1938; cost	2,000.00
	$16,046.37
Deposited in Savings Account, American Security & Trust Co.	8,314.12
Total	$24,360.49
Bank Balance December 31, 1938	1,514.94
Total Assets	$25,875.43

ALLOTMENTS

	Allotted Receipts		*Expended*	
Secretary's Office	$ 450.00		$ 171.90	(1)
Treasurer's Office	225.00		202.52	(2)
Journal	2,400.00	+$1,476.26 = $3,876.26	3,102.80	(3)
Meetings Committee	350.00		223.60	
Membership Committee	10.00			
Executive Committee	10.00			

Bills outstanding, not paid, at end of year:

(1) Secretary's Office	$105.70
(2) Treasurer's Office	2.75
(3) Journal	379.55

* The bond of the Chicago Railways Company was not paid upon maturity due to the expiration of franchise and failure of the Legislature to enact continuing legislation; interest has been paid to date under authority of the Courts, and $250 has been paid on the principal since maturity.

The Auditing Committee, W. A. DAYTON, ALBERT R. MERZ, and PAUL A. SMITH reported:

We, the undersigned members of the committee appointed to audit the accounts of the Treasurer of the Washington Academy of Sciences for the year 1938, desire first to compliment Treasurer H. G. AVERS on the

careful and orderly manner in which his records are kept, and to express our appreciation of the courtesy extended to us by Mr. AVERS and his assistant, Mr. MEADS. This had greatly facilitated the work of the auditing committee.

The Treasurer's records of receipts and expenditures, as shown in his account books and included in his report, have been carefully examined and found correct. All vouchers have been found to be correct and properly approved.

The balance sheets submitted by the bank and the securities listed in the Treasurer's report have been examined. The statement of the assets of the Academy was found correct.

No coupons not yet due were missing from any of the coupon-bearing securities.

It was moved to accept the reports of the Treasurer and the Auditing Committee and to place them on file. By vote it was so ordered.

The Board of Editors, EBEN H. TOOLE, FREDERICK D. ROSSINI and C. LEWIS GAZIN submitted the following report:

Volume 28 for 1938 has 556 pages, or 8 pages more than the preceding volume. This was an average of 46¼ pages per number. Of the 72 original contributions, 10 were addresses before the Academy or affiliated societies and 2 were brief corrections of previous articles in the Journal. Forty papers discussed biological forms new to science. Of the original papers, 41 were by members of the Academy and 31 were by non-members. The papers were illustrated by 22 halftones, and 64 line cuts, occupying 58 pages. Obituaries appeared of 8 deceased members. In addition to the proceedings of the Academy, which occupied 7 pages, 4 affiliated societies published their proceedings in the Journal. The Philosophical Society furnished approximately 25 pages with abstracts of 37 papers presented before that society; the Chemical Society about 11 pages, with 17 abstracts; the Geological Society about 10 pages, with 14 abstracts; and the Botanical Society 5 pages, with 12 abstracts. All of the proceedings occupied somewhat more than one average sized number.

The total net cost to the Academy of issuing the Journal for 1938 was $3,319.08, compared with $3,216.46 for 1937. The cost of printing was $4.91 per page, which included $0.12 per page for alterations. The comparable cost per page for printing in 1937 was $4.81. The cost of engravings was approximately $5.54 per page of illustrations or $0.58 per page, based on number of pages in the volume. A portion of this cost was paid by authors. The total cost to the Academy of reprints furnished free to authors was $222.75.

The report of the Board of Editors was accepted and ordered placed on file.

The Tellers, S. F. BLAKE, N. R. ELLIS and H. S. ISBELL, reported the election of the following officers: President, CHARLES E. CHAMBLISS; Non-resident Vice Presidents, H. S. GRAVES and R. B. SOSMAN; Corresponding Secretary, NATHAN R. SMITH; Recording Secretary, OSCAR S. ADAMS; Treasurer, H. G. AVERS; Board of Managers (to serve 3 years) J. H. HIBBEN and G. STEINER; (to serve 2 years to fill a vacancy) H. C. FULLER.

The Corresponding Secretary read the list of nominations for Vice-Presidents submitted by the affiliated societies as follows:

Philosophical Society—F. G. BRICKWEDDE.
Anthropological Society—HENRY B. COLLINS, JR.
Biological Society—W. B. BELL.
Chemical Society—B. H. NICOLET.

Entomological Society—AUSTIN H. CLARK.
National Geographic Society—ALEXANDER WETMORE.
Geological Society—H. D. MISER.
Medical Society—FRED O. COE.
Historical Society—ALLEN C. CLARK.
Botanical Society—G. F. GRAVATT.
Archeological Society—ALES HRDLICKA.
Foresters—W. A. DAYTON.
Washington Society of Engineers—PAUL C. WHITNEY.
Electrical Engineers—H. L. CURTIS.
Mechanical Engineers—H. L. WHITTEMORE.
Helminthological Society—E. W. PRICE.
Bacteriological Society—L. A. ROGERS.
Military Engineers—WILLIAM BOWIE.
Radio Engineers—J. H. DELLINGER.

By vote of the Academy, the Recording Secretary was instructed to cast one ballot for the list as read. This was done and the Vice-Presidents were declared duly elected.

President Howe appointed Past Presidents WETMORE and TUCKERMAN to escort President-elect CHAMBLISS to the chair. President CHAMBLISS thanked the Academy for the honor conferred upon him and urged upon all to be mindful of their duty to the Academy.

Adjournment followed at 10 P.M.

OSCAR S. ADAMS, *Recording Secretary*

CHEMICAL SOCIETY

503RD MEETING

The 503rd meeting was held in the Auditorium of the Cosmos Club on Thursday, October 27, 1938, with President DRAKE in the chair. This was the first of the newly initiated informal meetings. The society was addressed as follows:

B. J. MAIR: *The chemical composition of the lubricant fraction of a midcontinent petroleum.*—The results of a joint investigation of the Bureau of Standards and the American Petroleum Institute on the chemical composition of the lubricant fraction of a midcontinent petroleum were reported. The lubricant fraction was separated into a "wax" portion, an "asphaltic" portion, an "extract" portion and a "water-white" oil portion. The water-white oil portion was first separated by distillation into substantially constant-boiling fractions. Charges of these fractions were prepared and each charge of about 500 g. separated by extraction with acetone in 14 m. columns into 25 to 35 fractions. A number of properties were determined on these fractions each of which represents 1/40,000 part of the original crude petroleum (Mair and Schicktanz, J. Research NBS 17: 909, 1936). The data on these fractions was correlated with data available in the literature on synthetic hydrocarbons, and conclusions drawn as to their constitution (Mair and Willingham, J. Research NBS 17: 923, 1936).

The extract portion was then investigated in an analogous manner by distillation followed by extraction of charges with narrow-boiling ranges, except that in this instance methyl cyanide was used as the solvent. A large number of physical properties were determined on these fractions (Mair and Willingham, J. Research NBS 21: 535, 1938).

To obtain information as to the amount of aromatic hydrocarbons in these fractions, a selected 15 of them were completely hydrogenated, and the physical and chemical properties of the hydrogenated fractions determined (Mair, Willingham and Streiff, J. Research NBS 21: 565, 1938). The sulfur, nitrogen, and oxygen were removed from the fractions, and the fractions were completely converted to naphthenes by the hydrogenation process. There was no change in the number of carbon atoms per molecule.

Finally a correlation was made (Mair, Willingham, and Streiff, J. Research NBS 21: 581, 1938) of the data on the extract fractions, the hydrogenated fractions, the water-white oil fractions, and of the data available in the literature on synthetic hydrocarbons. The conclusions resulting from the correlation were that, excluding the "wax" and "asphaltic" portions, the oil contains: (1) about 60 per cent of naphthenes with from 1 to 3 naphthenic rings per molecule (a very small amount of material containing 4 naphthenic rings per molecule is probably present also); (2) about 15 per cent of material with 1 aromatic ring and with from 1 to 3 naphthenic rings per molecule, together with a small amount of sulfur and oxygen compounds; (3) about 14 per cent of material with 2 aromatic rings (linked through two common carbon atoms) and 2 naphthene rings per molecule, together with a small amount of sulfur and oxygen compounds; and (4) about 11 per cent of material with more than 2 aromatic rings per molecule (each probably linked through 2 common carbon atoms) and 1 or 2 naphthene rings per molecule, together with some sulfur, nitrogen, and oxygen compounds. (*Author's abstract.*)

504TH MEETING

The 504th meeting was held in the Auditorium of the Cosmos Club on Thursday, November 10, 1938, with President DRAKE presiding. The program was preceded by the annual election of officers for the ensuing year. The following were elected: *President:* FRANK C. KRACEK, Geophysical Laboratory; *Secretary:* RAYMOND M. HANN, National Institute of Health; *Treasurer:* NORMAN BEKKEDAHL, National Bureau of Standards; *Councilors:* N. L. DRAKE, H. T. HERRICK, J. H. HIBBEN, G. E. HILBERT, G. E. F. LUNDELL, B. H. NICOLET, B. D. VAN EVERA; *Board of Managers:* A. H. BLATT, P. H. GROGGINS, H. L. J. HALLER, F. D. ROSSINI, J. F. SCHAIRER, E. R. SMITH. The Society was then addressed as follows:

LOUIS F. FIESER, Harvard University: *Cancer producing hydrocarbons.*—During the eight years since the discovery that pure 1, 2, 5, 6-dibenzanthracene has the ability to produce malignant growths in test animals, particular attention among workers in the field has been given to the biological investigation of this hydrocarbon and of two other polynuclear aromatic hydrocarbons. 3, 4-Benzpyrene is of special interest because it produces tumors with great rapidity and because, as it is a constituent of carcinogenic tars, it undoubtedly has been responsible for the induction of skin cancer in humans. Of even more interest is the highly potent carcinogen methylcholanthrene, for this bears some structural relationship to sex hormones arising in the body as products of normal steroid metabolism, and it has been produced by the chemical degradation of two acids normally present in the bile, and also from cholesterol.

An analysis of the collected data from biological experiments conducted in numerous research centers reveals a number of points of interest concerning the actions of these three hydrocarbons. They all produce tumors with such uniform regularity, when tested under suitable conditions in non-re-

sistant tissues, that the most significant criterion of relative potency is given by the average time required for the induction of tumors. The average induction time, for a given tissue, a given technique of administration, and a given dosage, is a reasonably reproducible and accurately determinable quantity. Consideration of pertinent data affords significant information on the influence of the nature, state, and dosage of the hydrocarbon administered, and on such variable factors associated with the nature of the test animal as the sex, age, strain, species, and tissue. With this information, it is possible to correlate a large body of data on a comparable basis and to arrive at critically weighted average values for the induction periods of the three hydrocarbons as tested in various tissues of rats and mice. It is concluded that all three compounds act somewhat more rapidly when injected subcutaneously into mice than when applied to the skin, and produce a more rapid response in the subcutaneous tissue of mice than of rats. Methylcholanthrene is perhaps slightly more potent than 3, 4-benzpyrene, and both substances act considerably more rapidly than 1, 2, 5, 6-dibenzanthracene.

In seeking to discover the structural features responsible for the marked cancer producing properties of methylcholanthrene, a number of simpler substances having various features of its structure have been synthesized and tested. The closest approach to a simpler model-compound has been found in 10-methyl-1,2-benzanthracene, and it has been concluded that the feature of structure of greatest importance in methylcholanthrene is the presence of a 1,2-benzanthracene ring system with an alkyl substituent at the meso position 10. Substitution in the alternate meso position 9 is also favorable for carcinogenic activity, but to a lesser extent, and there are definite indications of a reinforcing function of alkyl groups in a meso and an α-position in the anthracene nucleus. Studies of possible models of 3,4-benzpyrene have not progressed as far, but it appears at present that this hydrocarbon probably has a structure unique unto itself.

Relationships between structure and carcinogenic activity have been sought in the hope of finding a clue to the nature of the action of the hydrocarbons in initiating malignancy. Another line of attack has been to search for some special chemical or physical property of the hydrocarbons which might be correlated with their biological actions. In recent work a special chemical property has been discovered. It has been found that methylcholanthrene and 3,4-benzpyrene, the most potent of the known carinogenic hydrocarbons, possess chemical reactivity of a specific kind to a degree not previously encountered in any known aromatic hydrocarbons. They show a remarkable susceptibility to substitution reactions, as exemplified in diazo coupling, oxidation with lead tetraacetate, and condensation with methylformanalide. From such results as have been obtained in the brief period since the first recognition of this unsuspected property, it appears that there is at least a rough correlation between the chemical reactivity of the hydrocarbons and their carcinogenic activity. Coupled with biological results indicating that the hydrocarbons undergo rapid chemical reaction in contact with animal tissue, the observations suggest that the first step in the action of a carcinogen in the induction of malignant growth consists in a substitution reaction. It is conceivable that this may consist in a hydroxylation, or in the introduction of a sulfhydryl group or an amino residue. (*Author's abstract.*)

505TH MEETING

The 505th meeting was held in the Auditorium of the Cosmos Club on Thursday, December 8, 1938, with President DRAKE in the chair. The

President announced with sorrow the passing of CHARLES EDWARD MUNROE, in his 89th year, on December 7, 1937. Professor MUNROE was past president of both the Chemical Society of Washington, and of the American Chemical Society. The following resolutions were read into the minutes of the Society:

"In the death of Professor CHARLES EDWARD MUNROE on the afternoon of December 7, 1938, at the age of 89 and a half years, the Chemical Society at Washington has suffered an irreparable loss. During his forty-six years of residence in Washington, Professor MUNROE's activities were so closely interwoven with those of this local society that they constitute an almost unbroken record of service in one connection or another. Immediately after his coming to Washington in 1892 as Professor of Chemistry at Columbian (later George Washington) University, he took an active part in the movement that led to the incorporation of the existing Chemical Society of Washington as a section of the American Chemical Society. In 1896 he became the twelfth president of this Society, and, until the time of his retirement as Chief Explosives Chemist of the Bureau of Mines in 1934, maintained an active interest in all phases of its work. As a charter and life member of the American Chemical Society, and as the oldest of its past presidents, he was regarded not only locally but nationally as the beloved dean of American Chemistry.

Of the many occasions at which Professor MUNROE appeared upon our program, the most memorable was at the 400th meeting on March 29, 1928, when he, Dr. H. W. WILEY, and Dr. F. W. CLARKE, all former presidents of the Society and past presidents of the American Chemical Society, were the speakers and guests of honor. The reminiscences of Professor MUNROE at this meeting, narrated with the delightful charm of manner that was so characteristic of all that he did, are still fresh in the minds of all who were then present.

The great and lasting services of Professor MUNROE to American Chemistry are too well-known to require mention in the present resolution. Be it, however,

Resolved that a Committee of the Chemical Society of Washington be authorized to collaborate with the American Chemical Society in the preparation of a comprehensive review of the contributions of Professor CHARLES EDWARD MUNROE to the Science and Art of Chemistry, and be it also

Resolved that this expression of regret on the death of our fellow member and past president, Professor CHARLES EDWARD MUNROE, be recorded in the minutes of this Society and that a copy thereof be sent with our expressions of sympathy to Mrs. MUNROE and the members of her family."

The meeting was addressed by Professor E. BERL, of the Carnegie Institute of Technology, who spoke on *the practical aspects of cellulose derivatives.* The speaker discussed in detail the preparation, stability, and fabrication of the many industrially important derivatives of cellulose, particularly with respect to their use in synthetic yarns and similar products.

FRANK C. KRACEK, *Secretary*

Obituary

GEORGE HERBERT GIRTY, geologist of the Geological Survey and specialist on Carboniferous and Permian formations and faunas, died at his home, 3600 Macomb Street, N.W., Washington, D. C., on Friday, January 27, of a heart ailment. Doctor Girty was born December 30, 1869, in Cleveland, Ohio. He was educated in the public schools of Cleveland, and at Yale University. He received his A.B. from Yale in 1892, and his Ph.D. in 1894. He joined the staff of the Geological Survey in 1895, and was a valued member of that organization continuously from then until his death, a period of 44 years.

Doctor Girty made field investigations of Carboniferous and Permian rocks in nearly all states and territories in which they occurred, and described the invertebrate faunas of the formations studied. More than any other man, Doctor Girty laid the broad foundations for the present day interpretations of the Carboniferous geology of the West and Southwest, as well as for Alaska. He is most widely known for his classical studies of the Permian faunas of Texas, but nearly all of his papers are used and cited throughout the world. He was the author or part author of 9 Professional Papers and 12 Bulletins of the Survey, and of about 50 other articles. His written opinions and memoranda on Carboniferous problems, most of which are printed in the reports of his colleagues, must approach a thousand.

Doctor Girty was a member of the American Association for the Advancement of Science, the Geological Society of America, the Paleontological Society, the Washington Academy of Science, the Geological Society of Washington, and Phi Beta Kappa.

A direct, penetrating thinker, a critic who could detect fallacy with unerring accuracy, no matter how subtly or elaborately it was camouflaged, a man with a strong sense of justice and fairplay, frank, honest, faithful, George H. Girty will be sadly missed in his profession and among his friends.

CHARLES EDWARD MUNROE, dean emeritus of the School of Graduate Studies of George Washington University, died at his home in Forest Glen, Maryland, on the afternoon of December 7, 1938. Dr. Munroe was born at Cambridge, Mass., May 24, 1849. He graduated *summa cum laude* from Harvard in 1871, and for the next three years taught chemistry there and established the first course in chemical technology. He left Harvard in 1874 to accept the professorship of chemistry at the United States Naval Academy, where he remained until 1886. He next served as chemist of the United States Naval Torpedo Station and War College at Newport, R. I. In 1892 he became Professor of Chemistry and also served as Dean of the Graduate School of George Washington University until his retirement in 1918.

Dr. Munroe was the inventor of the smokeless powder "Indurite." He was engaged in many public services. His copious reports for the censuses of 1900, 1905, and 1910, as expert agent in charge of chemical industries, are invaluable for their wealth of historical and statistical information. He served also at various times as consulting expert for the U. S. Geological Survey, the U. S. Forestry Service and the Civil Service Commission, and was chairman of the advisory committee of the American Railway Association for drafting regulations on the safe transportation of explosives. He was chairman of the Committee on Explosives of the American Society of Testing Materials and also of the Committee on Explosives Investigations of the National Research Council. No less extensive were Munroe's services

for the numerous scientific societies of which he was a member. In 1873 at the meeting of the American Association for the Advancement of Science in Portland, Maine, he was secretary of a group of distinguished chemists (among whom were seven future presidents of the American Chemical Society) who petitioned the Association for the formation of a subsection of Chemistry. He was also the last surviving charter member of the American Chemical Society (founded in 1876) which honored him with its presidency in 1898. His services to this body, of which he was a life member, were of the highest order. He served continuously as Associate Editor on Explosives for Chemical Abstracts from the first issue of this Journal in 1907 until death terminated the activity of his pen.

In addition to the various domestic and foreign chemical societies to which he belonged, Munroe was a member of the American Association for the Advancement of Science, the American Philosophical Society, the American Academy of Arts and Sciences, and an honorary member of the Washington Academy of Science. He was a recipient of numerous honors, among which were a membership of the Turkish Order of Medjidieh and a decoration of the Order of Leopold from Belgium.

EDMUND CECIL SHOREY passed away, after a period of illness, on Monday, January 30, at Emergency Hospital, Washington, D. C. Dr. Shorey was born in Lanark County, Ontario, on March 5, 1865. He secured both his undergraduate and graduate education at Queens University, Kingston, Ontario, with the B.A. degree in 1886, the M.A. in 1887, and the D.Sc. in 1896. This institution also honored him with a gold medal in chemistry and a silver medal in natural science. For the year following his graduation he was connected with Queens University as a demonstrator in chemistry. From 1888 to 1891, he was engaged in private analytical work and assaying. Dr. Shorey entered the field of industrial chemistry when he became chemist for the Kohala Sugar Company of Hawaii. In 1899 he was appointed Chemist of the Territory of Hawaii and served in this capacity until 1903, when he became Chemist of the Hawaii Agricultural Experiment Station. After four years with this institution he was transferred to the Division of Soil Fertility Investigations, Bureau of Soils, U. S. Department of Agriculture. His long association with the Department was only interrupted by a brief return to commercial research in 1918 to 1921. In the Division of Soil Fertility Investigations he attained the rank of Senior Biochemist, and, upon retirement in 1935, remained as a Collaborator.

Dr. Shorey's chief interest and activity in chemical research was the biochemical aspect of the organic matter of soils as related to plants. This research is covered by numerous papers and bulletins and the results of this work gained him international recognition. His intense interest in this field of organic chemistry was maintained until the last, as evidenced by the publication last March of his work upon the isolation and identification of allantoin from several soils.

Dr. Shorey was a fellow of the American Institute of Chemists, and a member of the American Association for the Advancement of Science, the American Chemical Society, the Society of Biological Chemists, and the Washington Academy of Sciences.